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Residential Ventilation Requirements

A RESEARCH REPORT

Canada

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Residential Ventilation Requirements

A RESEARCH REPORT

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RESUME

À mesure qu'on améliore l'étanchéité des maisons, il faut penser davantage à l'apport d'air frais, particulièrement pendant l'hiver, saison pendant laquelle les fenêtres restent fermées. La ventilation et les sources de pollution intérieures influent sur la qualité de l'air. Le nouveau Code du bâtiment (édition de 1985) devrait régler ce problème, puisque pour la première fois, il exige l'installation dans toutes les nouvelles maisons d'un dispositif de ventilation mécanique capable de produire un demi-renouvellement d'air par heure pendant la saison de chauffage.

L'ébauche de ce rapport passe en revue les exigences en matière de ventilation des maisons du Code du bâtiment et des codes provinciaux, dans l'ensemble du pays, et décrit comment elles sont interprétées et appliquées dans sept villes différentes. Les renseignements fournis par les inspecteurs et l'industrie du bâtiment donnent un aperçu du mode d'application de ces normes. Un examen des dispositifs et des normes de ventilation a permis d'établir quels produits et quelles procédures sont actuellement utilisés dans ce domaine.

Le rapport comprend également un résumé d'autres normes canadiennes et des exigences minimales en Europe et aux Etats-Unis; il est ainsi possible de faire des comparaisons et de voir dans quelle direction s'orientent les changements.

Ces renseignements pourront servir d'outils de travail valables pour toute personne chargée d'étudier les questions de ventilation résidentielle, tant celles qui font partie de la longue filière des auteurs du code, des inspecteurs d'immeubles, des concepteurs, des entrepreneurs et, finalement, des propriétaires de maisons, que celles qui veulent s'assurer que les maisons canadiennes sont convenablement ventilées.

RESUME

Les principaux points du rapport sont présentés en **caractères gras** comme ceux-ci, afin que les lecteurs puissent s'y référer rapidement. Les sources des citations indirectes ne sont pas indiquées.

Le lecteur trouvera un sommaire du présent rapport en français, à la page i.

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En 1985, les normes de ventilation des maisons canadiennes ont été considérablement modifiées.

Ventilation mécanique

Dans sa dernière édition (1985), le Code national du bâtiment prévoit pour la première fois l'installation de dispositifs de ventilation mécanique capables de produire un demi-renouvellement d'air par heure selon le volume habitable du logement pendant la saison de chauffage, quelles que soient les conditions (neige, accumulation de glace ou basses températures).

Les précédentes normes de ventilation, établies en fonction de chaque pièce, étaient fondées sur la ventilation naturelle par les fenêtres ou sur la ventilation mécanique à un taux d'un renouvellement d'air par heure. Dans les faits, seules les cuisines et les salles de bains étaient dotées de dispositifs de ventilation mécanique. On supposait alors que l'infiltration d'air et les fuites à travers la structure assuraient un apport d'air suffisant. Ces exigences tiennent toujours, mais ne s'appliquent plus qu'en dehors de la saison de chauffage, dans les maisons non dotées de climatiseur central.

Contexte

La règlementation concernant l'utilisation des fenêtres pour la ventilation découle des exigences en matière d'éclairage et est fondée sur un pourcentage de la surface de plancher. Lorsque les codes ont été élaborés, les fenêtres à guillotine à deux châssis constituaient la norme, et les exigences de ventilation correspondaient à la moitié de la surface requise aux fins de l'éclairage. Plus tard, on a établi une surface standard de ventilation pour chaque pièce. On s'entendait alors sur le fait que l'autre exigence, soit l'installation de ventilateurs assurant un renouvellement d'air par heure, était supérieure au minimum requis pour assurer une bonne qualité de l'air.

La norme d'un renouvellement d'air par heure s'applique à chaque pièce. Toutefois, les ventilateurs standards dont la puissance varie de 25 à 125 L/s (50 à 250 pi 3/min), peuvent assurer une ventilation suffisante de toute la maison et non seulement de la pièce où ils sont installés.

Au Canada, aux Etats-Unis et en Europe, les spécialistes jugent raisonnable la nouvelle norme d'un demi-renouvellement d'air par heure, tant au point de vue de la qualité de l'air qu'à celui de l'élimination de l'humidité. Le code contient également des normes concernant l'air de compensation, mais n'exige pas l'installation de ventilateurs introducteurs, de systèmes symétriques ou de systèmes de distribution. Les auteurs du code supposent qu'un ventilateur installé dans une cuisine ou une salle de bains et doté d'une sortie d'air au sous-sol permet de respecter les exigences.

Adoption du code

Au Canada, toutes les compétences ont adopté le Code National du bâtiment ou une version qu'elles ont elles-mêmes modifiée. Seules l'Alberta et l'Ontario ont adopté des normes de ventilation plus précises. Le 30 juin 1985, l'Alberta a été la première à adopter le nouveau Code comme norme provinciale, mais sans savoir exactement comment elle se chargerait de l'application des nouvelles règles en matière de ventilation. Les autres provinces et territoires devaient adopter le nouveau Code en 1985 ou en 1986.

Mise en vigueur

Un sondage réalisé dans sept villes, a permis d'établir comment elles mettent en application les exigences en matière de ventilation naturelle ou mécanique. Au mieux, les autorités municipales se contentent de vérifier les dimensions des fenêtres et des ventilateurs d'évacuation. Elles n'effectuent ni calculs ni vérifications de rendement. Il est fort probable que la nouvelle exigence (un demi-renouvellement d'air par heure) subira le même sort, puisque le CNB de 1985 ne contient aucune mesure visant à confirmer que le taux exigé peut être atteint, particulièrement pendant la saison froide.

Matériel

Les ventilateurs récupérateurs de chaleur, fabriqués en série et vendus tels quels, répondent aux nouvelles exigences. Ces produits, de même que leur installation, sont déjà assujettis à des normes, et le programme d'accréditation des installeurs est déjà en vigueur. Le programme R-2000 en exige déjà l'installation. Il n'existe encore aucune norme concernant les dispositifs de ventilation symétrique qui ne sont pas dotés de récupérateurs de chaleur.

Problèmes

La dernière édition du Code national du bâtiment présente la nouvelle exigence, mais ne prévoit aucun moyen d'en assurer la mise en application. Les auteurs du code et l'industrie de la construction n'attachent pas beaucoup d'importance à la ventilation. Il est probable que quelques constructeurs installeront des ventilateurs récupérateurs de chaleur, mais que la plupart se contenteront des ventilateurs d'évacuation courants, dotés de sorties d'air au sous-sol. L'expérience, en ce qui a trait aux conduits d'approvisionnement en air de combustion, a démontré que les propriétaires de maison bouchent rapidement ces ouvertures.

Le programme R-2000 et les nouvelles normes de construction de maisons dans le Nord contiennent des exigences plus précises, mais il reste toujours à déterminer comment elles peuvent être mises en application sans l'utilisation de ventilateurs récupérateurs de chaleur installés conformément aux normes de l'ACNOR. Jusqu'à ce que cette question soit résolue, il sera difficile d'assurer le respect de la nouvelle exigence du Code national du bâtiment.

Concerns about energy have had more impact on house design in the last ten years than in the previous fifty. New products and improved construction techniques over the past decade have produced significant changes to the way that houses are built.

A recent 27-page feature on housing trends in The Atlantic magazine emphasizes these points, adding that the overall energy efficiency of new U.S. housing has risen 30 to 50 percent since 1973 thanks to increased insulation and tighter air sealing.[1] But the article makes the important point that "alterations in the physical characteristics of houses cannot automatically be presumed safe."

Background

The cold Canadian climate imposes conditions on tight houses that didn't occur with leaky buildings where winter's icy drafts supplied more fresh air than was needed and loose construction details allowed the accumulated odours and indoor air contaminants to escape. With today's tighter houses, the traditional building code requirements for openable windows or exhaust-only fans may not be sufficient to ensure adequate ventilation for the health and safety of the occupants. Furthermore, depressurization due to exhaust fans can cause backdrafting of combustion equipment.

Now, indoor air quality and assured ventilation have become major issues. Interest among design and construction professionals has been so strong in these problem areas that in 1983, the National Research Council's Division of Building Research toured 13 Canadian cities with a panel of experts presenting a series of one-day workshops on Humidity, Condensation and Ventilation in Houses. Over 1400 participants attended.

There, they learned about factors influencing air leakage in houses -- wind, stack effect and chimneys. One building scientist pointed out that the leakiest house will provide too much ventilation under wind or stack action but not enough under a no-wind, no-stack-effect condition. "Even if we wanted to," he said, "making houses leakier provides no guarantee of adequate ventilation at all times."[2] Even if the problem of indoor air quality is more pronounced in airtight houses, it exists in leaky houses as well.

These concerns, together with the recognition that new contaminants are being introduced with building materials, furnishings and occupant activities, has reinforced the need to provide controlled ventilation systems in houses. An article on air quality in a technical newsletter, Energy Design Update, concludes that the most effective solution is a reliable and effective mechanical ventilation system with an assured fresh air supply.[3]

Some experts feel that improved ventilation is not the only solution to indoor air quality. Other solutions include reducing pollution by limiting the sources or recirculating indoor air through an air cleaner or air wash. Increased ventilation, however, remains the major strategy and is the topic of this report.

Ventilation Requirements

Ventilation requirements start with the fact that humans consume oxygen and exhale carbon dioxide. Theoretically a minimum of 1.5 litres per second per person is required to keep carbon dioxide levels at a safe concentration for inactive people. To allow for increased activities and to handle body odours, a minimum of about 2.5 litres per second has been recommended and 5 litres per second per person is suggested to handle normal contaminants and odours.[4]

The current ASHRAE Standard 62-1981 for ventilation requires a base ventilation rate of 5 litres per second per room, with additional intermittent capacity in kitchens and bathrooms. For a typical house with eight to ten rooms, that works out to a minimum rate of 40 to 50 L/s. Canadian studies have also shown that 30 to 50 L/s is required to control humidity and contaminants such as combustion gases, formaldehyde and radon.[5]

For typical houses this rate of 50 L/s works out to about 0.5 air changes per hour (ach), the same figure that is specified in the new Canadian building code. Recent codes in the Scandinavian countries and in some of the northern United States now contain similar figures for required ventilation rates.

Mechanical Ventilation

Conventional mechanical ventilation in housing relies on simple exhaust fans, typically installed in hoods over the kitchen stove or in bathroom ceilings. These exhaust-only systems rely on leakage and natural ventilation to supply the replacement air.

The more advanced supply-and-exhaust systems provide outdoor air to balance the amount of indoor air that is exhausted. The outdoor air can be supplied either by a correctly sized passive opening somewhere else in the building, as required by the new National Building Code, or by both supply and exhaust fans in a single piece of equipment. A heat recovery ventilator, sometimes called an air-to-air heat exchanger, is an example of a supply-and-exhaust system.

An excellent overview of international research into natural and mechanical ventilation strategies can be found in an IEA report entitled Ventilation Strategy -- a selected bibliography (Air Infiltration Centre's Technical Note 17) published in July 1985 -- too late to be included in this report.[6]

CHAPTER ONE REFERENCES

1. Philip Langdon, "The American House: What we're building and buying in the eighties," The Atlantic Monthly, September 1984, pp. 45-73. The quotation is from p. 57.

2. Humidity, Condensation and Ventilation in Houses, Building Science Insight '83, Proceedings No. 7, Division of Building Research, National Research Council, Ottawa, May 1984, NRCC 23293, 66 pages, softbound, $3.50. The quotation by G.O. Handegord is from page 47.

3. "Air Quality Measurements in Airtight Houses," Energy Design Update, January 1985, pp. 3-5. The article reviews work conducted by NRC's Rob Dumont and presented in Air Quality Measurements in Low-Leakage Houses, Building Research Note 218, Divison of Building Research, September 1984, 14 pp plus appendix.

4. See "Ventilation and Air Quality," NRC's Canadian Building Digest No. 110. A photocopy is included in the Appendix.

5. See Ventilation Requirements for Airtight Homes by TES Ltd., BETT Publication No. 83.04, 45 pages plus references, bibliography and an appendix.

6. Yvette Parfitt, Ventilation Strategy -- a selected bibliography, Technical Note AIC 17, Air Infiltration Centre, International Energy Agency, July 1985, ISBN 0 946075 2 1 2, 24 pages.

2. PURPOSE

The purpose of this study is to review the codes and standards relating to low-rise housing ventilation requirements and to assess their application in the housing industry. The information is of interest to homeowners, builders, scientists and regulators across Canada who are concerned about possible side-effects of tightening houses, either new or retrofits, for energy conservation.

This report examines ventilation requirements at the national, provincial and municipal levels and compares them to their European and U.S. counterparts. The review attempts to track down the technical soundness of the specific requirements, and to ascertain the extent of their enforcement across Canada in both houses and mobile homes.

Because the 1985 edition of the National Building Code was released during the study, the scope has been expanded to examine the code adoption process to see when the new requirements might be in place, and determine how building officials will likely enforce the new requirement for mechanical ventilation capability throughout the winter heating season.

The study began by collecting and reviewing the national and provincial codes and standards relevant to low-rise housing and mobile homes to determine what they actually require and how long the requirements have been in effect. Municipal bylaws related to residential ventilation requirements were covered by a sample survey with representatives of municipal building departments in seven major Canadian cities -- Halifax, Montreal, Ottawa, Toronto, Winnipeg, Saskatoon and Vancouver. Other requirements were determined by interviewing spokesmen for such organizations as CMHC, CSA, and HRAI.

The technical basis or rationale lying behind the code requirements was ascertained through interviews with code authorities and any activity toward modifying the requirements was noted.

Information on the interpretation and enforcement of the requirements, including new construction and renovation, was obtained through telephone interviews with federal and provincial code authorities and with local building officials and inspectors.

Trade practices were determined by examining available products and existing standards and by interviewing representatives of the building industry and equipment manufacturers. Ventilation requirements in Europe and the U.S.A. were reviewed for comparison with Canadian requirements.

This report presents the result of that overall study and provides an Appendix with photocopies of the codes and related documents, plus a list of organizations contacted. During the fall of 1985, copies of the final draft were sent out to approximately 50 reviewers, including referenced sources and other experts. Their comments and corrections have been included in this final version.

This chapter begins with background information on the National Building Code and on the committees which produce it. It then reviews the requirements in the 1980 NBC, which were still in effect in most of Canada when the report was prepared. Background information on the original source of the requirements and on their development over time is also presented.

The third section in this chapter discusses the new requirements in the new 1985 NBC, with some interpretation of the intent of the requirements. The chapter concludes with information on responsibility for complying with code requirements, plus information on the 1983 Measures for Energy Conservation, a companion document to the NBC.

Officially the National Building Code is an advisory or "model" document with no legal status until adopted by a province or municipality. Unofficially, it is the minimum standard against which Canadian building construction is judged.

The NBC now forms the basis for practically all building regulations in Canada. All provincial, territorial and municipal building codes are not only based on the NBC but the requirements are usually identical. Except for minor additions to the Alberta and Ontario codes, the National Building Code is de facto exactly what its title says.

The National Building Code is a safety and health related document only and is not related to other aspects of building quality. It contains regulations dealing with public health, fire protection, plumbing, heating and structural sufficiency. It applies to all new building construction, including factory-built housing and alterations and reconstruction of existing buildings.

Part 9: Housing and Small Buildings

All requirements relating to housing are contained in Part 9 of the National Building Code, and it is the ventilation requirements in that part only that are reviewed in this study.

Part 9 also applies to small buildings -- those up to three storeys in height and 600 m^2 in floor area -- except for institutional, assembly, and hazardous industrial uses.

1985 National Building Code

PART 9

HOUSING AND SMALL BUILDINGS

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4.1 Background Information

The National Building Code was first published in the early 1940's to encourage reasonable and uniform standards for health and safety in buildings. The NBC is periodically revised, usually every five years, as a set of minimum technical requirements in a form suitable for adoption.

National Building Code of Canada

First edition	1941
Second edition	1953
Third edition	1960
Fourth edition	1965
Fifth edition	1970
Sixth edition	1975
Seventh edition	1977
Eighth edition	1980
Ninth edition	1985
Tenth edition	1990

Associate Committee on National Building Code

The National Building Code is published by the National Research Council through its Associate Committee on the NBC (ACNBC). The Associate Committee members are appointed by the NRC to serve as individuals and not as representatives of specific groups or organizations. They are experts broadly representative of all major phases of building in Canada. The committee has direct responsibility for producing the code, although it must abide by the general policies of NRC. A photocopy of the membership list of the ACNBC for the 1985 NBC is included in the Appendix. NRC's Division of Building Research (DBR) provides technical and secretarial support at the direction of the committee.

The Associate Committees for the National Building Code and the National Fire Code produce a joint newsletter, NBC/NFC News, published irregularly but usually

several times a year, dealing with code-related items such as calling for committee candidates, describing progress on new editions and providing staff interpretations of code requirements.[1]

The ACNBC meets twice a year under its own set of rules and procedures. The committee is committed to public review of its work. For the 1985 version of the NBC, the proposed changes were published along with the rationale in the newsletter and in press releases inviting comment. Between November 1983 and February 1984, over 1,400 individual responses were reviewed by technical committees and then handed back to the full ACNBC in the form of letter ballots. Changes were then approved by the full committee in May 1984.

The process of code development is one of continual input from a Provincial Advisory Committee and a group of technical Standing Committees representing trade associations, industry groups, vested interests and the general public.

Provincial Advisory Committee

The Provincial Advisory Committee (PAC) was set up in the early 1970's at the request of the ACNBC as an independent advisory board on matters affecting provincial adoption of the National Building Code. Provincial ministries with jurisdiction for the building code were asked to recommend representatives. PAC drew up its own guidelines, including membership requirements. PAC usually meets twice a year and its chairmanship revolves every two years. The PAC chairman sits as an ex-officio member of the ACNBC as does the head of NRC's Codes and Standards Group.

Standing Committees

The major technical areas of the code are handled by a number of Standing Committees, each with responsibility for a major part of the NBC or one of the associated documents. Each Standing Committee is made up of experts in the particular field for which it is responsible. There are eight Standing Committees, plus a joint NBC/NFC committee on French terminology. The Provincial Advisory Committee acts as the Standing Committee on Administration.

National Building Code Standing Committees

Occupancy
Fire Protection
Structural Design
Heating, Ventilating and Air-Conditioning
Plumbing Services
Housing and Small Buildings
Barrier Free Design
Fire Performance Ratings

Standing committees are responsible for the technical content of the code, with the ACNBC giving direction on policy. They normally meet several times a year.

Changes in membership of the Standing Committees are keyed to the five-year NBC cycle and are phased so that one-third to one-half of the members change at the completion of each new edition to facilitate code developments and preserve continuity. The ACNBC has a membership subcommittee to ensure balanced Standing Committees and qualified selections. It receives applications from volunteers for membership and announce openings in the NBC/NFC News. Anyone with a background in building construction may apply.

Standing Committee members are selected on the basis of their individual qualifications, rather than as representatives of particular industries or interest groups. Membership is selected to provide a broad representation of viewpoints, both technically and geographically, from throughout the building community. Although the work is voluntary, members are reimbursed for out-of-pocket expenses while attending committee meetings.

In the spring of 1984, the Standing Committee on Housing and Small Buildings -- the group responsible for Part 9 -- were looking for provincial and municipal fire officials, for builders and associations representing mobile, factory-assembled and site-built housing and for architects in the private sector.[2] More than 450 persons applied for approximately 90 positions on both NBC and NFC committees.[3]

4.2 1980 National Building Code Requirements

Although the latest National Building Code was released in the spring of 1985, it will likely take most of 1986 before it is in force across Canada. In the meantime, the provisions of the 1980 version remain in effect and are reviewed here. (Those requirements which have changed with the 1985 edition are so identified in round brackets.) A photocopy of the full 1980 residential ventilation requirements is included in the Appendix.

NBC Numbering System

A decimal numbering system is used for all the requirements, with the same numbers being used in the provincial versions. The first number indicates the Part of the code, then the Section, Subsection and Article. Articles may be broken down into Sentences, Clauses and Subclauses, indicated by numbers in brackets.

1980 NBC Ventilation Requirements Numbering Scheme

Part	9	Housing and Small Buildings
Section	9.33	Ventilation
Subsection	9.33.1	Scope
	9.33.2	General
	9.33.3	Natural Ventilation
	9.33.4	Mechanical Ventilation

Ventilation requirements for residential occupancies are spelled out in Section 9.33. The basic requirement is simple:

Houses may use either natural or mechanical ventilation.
[1980 NBC: 9.33.2.1]

General Requirements

For non-residential small buildings, adherence to good engineering practice, such as ASHRAE procedures is required [Article 9.33.1.3]. If fan capacity is over 2 m^3/s, (converted from 4000 cfm in the 1975 NBC, the last issue to use Imperial measure) mechanical ventilation must conform with Part 6 of the code [Article 9.33.1.2]. Part 6, sometimes called the HVAC code, applies to all buildings except those covered by Part 9. (These general requirements are no longer contained in the 1985 NBC.)

Other general requirements relate to the type of heating system. If the house is electrically heated, a mechanical exhaust system with a 50 L/s (100 cfm) capacity is required. [Article 9.33.2.1.] (A bathroom or kitchen exhaust fan could meet this requirement, but it is no longer required in the 1985 version.)

If fuel-fired heating equipment is used, the required combustion air must be supplied, by natural or mechanical means. [Article 9.33.2.2.]

If the ventilation system forms part of the heating system, all the requirements of Section 9.34 Heating and Air Conditioning must be met. [Article 9.33.2.3.] Air contaminants released within the building must be removed, if possible, at their points of origin and "shall not be permitted to accumulate in unsafe concentrations." [Article 9.33.2.4.] (These requirements have now been moved to Part 6.)

According to the 1980 NBC, kitchens combined with living areas must have their own natural or mechanical ventilation. [Article 9.33.4.1.] This requirement does not occur in the 1985 code.

Natural Ventilation

Individual rooms or spaces relying on natural ventilation are required to provide a specified minimum openable area to the outdoors for different types of rooms, either a fixed figure or a percentage of the room's floor area. [Article 9.33.3.1.]

1980 Ventilation Requirements (cont'd in 1985 edition)

Table 9.33.3.A.
Forming Part of Article 9.33.3.1.

NATURAL VENTILATION		
Location		Minimum Unobstructed Area
Within *dwelling unit*	Bathrooms or water-closet rooms	0.09 m²
	Unfinished basement space	0.2 per cent of the floor area
	Dining rooms, living rooms Bedrooms, kitchens, combined rooms Dens, recreation rooms and all other finished rooms	0.28 m² per room or combination of rooms

Living rooms and dining rooms may ventilate through an adjacent vestibule. If the opening is other than a window it must provide weather and insect protection; any screening must be rust-proof. (These same requirements continue in the 1985 NBC.)

Mechanical ventilation

Where rooms or spaces are mechanically vented, the system must be capable of providing at least one air change per hour in that space.

1980 National Building Code

SUBSECTION 9.33.4. MECHANICAL VENTILATION

9.33.4.1. Where rooms or spaces are mechanically ventilated, the system shall be capable of providing at least 1 air change per hour. Where a kitchen space is combined with a living area, natural or mechanical ventilation shall be provided in the kitchen area.

The 1980 NBC contains no requirement for make-up or replacement air. It implies that normal construction techniques will allow sufficient infiltration to provide the incoming fresh air to replace the stale air exhausted by the fan.

Since all rooms except kitchens and bathrooms, laundry rooms and basement recreation rooms are required to have windows for light and safety, [Section 9.7 Windows and Skylights], this requirement really only applies to window-less kitchens and bathrooms. It may also apply to other rooms where windows are sealed units with no potential for ventilation.

This requirement does not specify that the required air change be made with fresh, outdoor air although code officials say this was the intent. The system does not have to actually provide one air change per hour, it simply has to be capable of doing so. No details are provided as to how this air change rate or the capability is to be determined. (This requirement for 1 ach for mechanically vented kitchens and bathrooms continues in the 1985 code.)

According to one of NRC's technical advisors on Part 9, the phrase "capable of providing" means that systems can be installed with switches. If the requirement were not phrased this way, he said, it might be interpreted as requiring the system to run continuously.[4] Even then the requirement may not be as rigorous as it seems -- a fan as small as 6 cfm [2.5 L/s) could meet the code for a typical tract housing bathroom: [(8 ft x 5 ft x 8 ft)/(60 min/hr) = 5.3 cfm]

A series of other requirements deals with the duct work. Inlets must be located to avoid contamination and exhausts must discharge to the outdoors and both must be weather and insect shielded. Equipment must be accessible for servicing. Intakes connected to the cold air return system must have dampers. Bathroom exhaust ducts are not required to be non-combustible provided they are reasonably air tight and impervious to water. [Articles 9.33.4. 2-12]. Requirements for ductwork are now found in Part 6 of the 1985 NBC.

Historical Background

Early standards grouped lighting and ventilation under the same heading and called for windows in most rooms to be 10 percent of the floor area for lighting purposes, which is still the case. The requirements assumed that each window was openable for 50 percent of its

area and thus ventilation requirements became 5 percent of the floor area.

According to NRC records, the figure for bathrooms appears to have originated in the 1953 NBC requirements which stipulated that

> "Toilet rooms shall contain a window of which not less than 50 percent can be opened and having an area of at least 2 square feet for each fixture."

Unfinished basement openable area ventilation requirements have decreased over the years from 1 percent of the floor area to 0.2 percent in recent versions. The bathroom requirement has similarly reduced from a 2 square foot minimum to 1 square foot. There is evidence of inconsistency between the National Building Code and Housing Standards, a separate set of standards produced by CMHC during the 1940's and 1950's before responsibility was taken over by NRC, but a general consensus on minimum values emerged in the 1960's. The ventilation area for bathrooms, by this time reduced to 1 square foot, and the 3 square foot requirement for other rooms appears to be based on traditional minimum acceptable room dimensions and, for the 1980 NBC, were simply converted to their metric equivalents. The 1985 NBC repeats the same numbers.

Electric Heating Requirements

The requirements for a mechanical exhaust system for houses with non-fuel-fired heating systems first occurred in a Builders' Bulletin issued by CMHC in 1972 to deal with excessive condensation and its potential harmful effects in buildings it would fund.[5] CMHC announced that it would require a 100 cfm exhaust fan in all electrically heated houses and wood-frame buildings. This is rated, not installed, capacity.

This requirement was first incorporated in the National Building Code in 1977 and in the 1980 edition was converted to its metric equivalent, 0.05 m3/s (50 L/s). It no longer occurs in the 1985 code.

CMHC's Builders' Bulletin, August 1972

> **Each dwelling unit shall be provided with a mechanical exhaust system such as bathroom and/or kitchen fan having a total capacity of 100 CFM or more at a static pressure of 0.1 inches of water. Fans shall be independently switched so as to permit the occupant to control their operation. All joints in the exhaust fan ducts shall be taped before insulation is applied and the ducts shall extend fully to the exterior. They should preferably be discharged at the exterior wall or the roof soffit rather than through the roof.**

This requirement reinforces the general consensus that 0.5 ach will ensure fresh air and reduce humidity. The required fan would provide exactly 0.5 air changes per hour for a typical Canadian bungalow of 1600 square feet (150 m^2) with a finished volume excluding the basement of 12,800 cubic feet (360 m3) :

[(0.05 m^3/s x 3600 s/hr)/(150 m^2 x 2.4 m) = 0.5 ach]

Although the required size of fan may be installed, there is no assurance that the rated capacity will actually be delivered. While the wall-mounted direct exhaust fans used in earlier days may deliver the full capacity, today's central exhaust systems using extended ductwork may only exhaust 70 to 80 percent, thus producing only 0.3 - 0.4 ach.

Product specifications for a late-model Canadian heat recovery ventilator indicates a similar 30 percent drop from a free air capacity of 265 cfm to an installed 195 cfm.[6]

Rationale for 1980 NBC Ventilation Requirements

Codes and standards are written by committees operating on the consensus principle.

It is clear that there is no technical basis for the natural ventilation requirements based on either room size or the number of occupants.

Ventilation requirements were derived from lighting requirements and the common double-hung window type used when the requirements were first drafted. Natural ventilation requirements imply that people will open their windows year around as fresh air is needed.

For mechanical ventilation the particular rate of 1 air change per hour was likely chosen by general agreement as a figure considered to be above the minimum required to assure good air quality.

Status of 1980 NBC

The 1980 NBC has been superceded by the 1985 edition, although the new version will have no legal validity until it is adopted locally or provincially. By mid-1985, several provinces had begun the review and adoption process but most were still a year or so away from adoption. Alberta was the first to adopt the 1985 version, closely followed by the Yukon.

4.3 1985 National Building Code Requirements

Background

A number of changes relating to residential ventilation requirements came into place with the 1985 National Building Code.

1985 NBC Ventilation Requirements

Part	9	Housing and Small Buildings
Section	9.33	Ventilation
Subsection	9.33.1	General
	9.33.2	Natural Ventilation
	9.33.3	Mechanical Ventilation

The most significant change is a new requirement for mechanical ventilation systems capable of supplying one-half air change per hour throughout the heating season in all new dwelling units. The supplementary exhaust requirements for kitchens and bathrooms without windows still apply.

All requirements formerly in Part 9 relating to central heating systems now come under Part 6. This change was made because the design and installation of heating systems have become the responsibility of professionals or specialized trades and are, for the most part, no longer performed by a builder's own crews or individuals building their own houses.[7] Part 6, however, calls up Part 9 to provide the requirements for natural ventilation in residential occupancies and for self-contained mechanical ventilation systems serving only one dwelling unit.

Thus, the ventilation requirements reviewed in this study continue to be those specified in Part 9.

1985 NBC Requirements

Section 9.33 applies to residential ventilation by natural means or by self-contained mechanical systems serving only one dwelling unit. Mechanical systems serving more than one dwelling must conform to Part 6. A photocopy of Section 9.33 Ventilation from the 1985 edition is included in the Appendix. To help identify changes from the earlier code, vertical lines are printed beside all new requirements.

Natural Ventilation

There are no changes in the 1985 National Building Code for natural ventilation. The same unobstructed openings are required as in the 1980 code.

Mechanical Ventilation

The significant new requirements for mechanical ventilation in the 1985 NBC are found in the first four articles of Subsection 9.33.3. Mechanical Ventilation.

1985 National Building Code

SUBSECTION 9.33.3. MECHANICAL VENTILATION

Mechanical ventilation required

9.33.3.1. *Dwelling units* shall have a mechanical ventilation system capable of providing at least one half an air change per hour during the heating season, based on the interior finished volume of the *dwelling unit*. The system shall be controlled either manually by a switch or automatically. (See Appendix A.)

9.33.3.2. Where rooms or spaces in *dwelling units* are provided with mechanical ventilation systems in lieu of natural ventilation as required in Article 9.33.1.5., the systems shall be capable of providing at least 1 air change per hour where summer cooling is not provided or at least half an air change per hour where summer cooling is provided.

Make-up air

9.33.3.3. Mechanical ventilation systems for *dwelling units* shall include provision for introduction of fresh make-up air from the exterior.

9.33.3.4. Mechanical ventilation systems in combination with central heating or cooling systems shall conform with Part 6.

All dwelling units are now required to have a mechanical ventilation system capable of providing at least one-half an air change per hour during the heating season, based on the interior finished volume of the unit. Provision for fresh make-up air is also now required. No distribution system is required and no product or installation standards are referenced to explain how the requirement is to be met or measured.

Summary

To summarize, the system may be either manually or automatically controlled. If a room is ventilated during the non-heating season mechanically rather than naturally (a bathroom without a window, for example) the mechanical system must still be capable of providing at least one air change per hour or at least one-half air change per hour if summer cooling is provided.

A ventilation system operating in conjunction with a central heating or cooling system comes under the jurisdiction of Part 6.

Requirements for the design and location of intakes, exhausts and system accessibility remain the same as in the 1980 National Building Code.

Interpretation

The NBC contains an Appendix of explanatory material. In that Appendix, the new requirement for a 0.5 ach rate is described as resulting from "the tendency toward achieving higher levels of airtightness in houses and other concerns over energy conservation [which] indicate that natural ventilation is not sufficient to ensure acceptable air quality during the winter heating season." A photocopy of the NBC Appendix note is included with the 1985 ventilation requirements in the Appendix of this report.

The new requirement does not call for a centralized ventilation system with ductwork throughout the house, and the mechanical system is deemed to be independent of natural sources, including windows and air infiltration.

According to the NBC Appendix, the requirement may be satisfied by means of exhaust fans located in the kitchen or bathroom if a fresh air inlet is provided at a location remote from the exhaust outlet. An NRC technical advisor to the ACNBC Standing Committee on Housing and Small Buildings, explains that the inlet should be remote so as to avoid short circuiting the exhaust, and it was assumed that no intake fan was required if an exhaust fan exhausted air at the required rate.[8]

In drafting the requirement, the committee assumed that something similar to a gas or oil furnace combustion air intake in the basement could be used for the air intake.[9]

A typical bathroom exhaust fan drawing about 60 cfm (28 L/s) would probably be interpreted as meeting the new code requirement as, in theory, it would have the capability of providing 0.5 ach for a 180 m^2 (1940 square foot) house.[10]

The intent of the committee was to exclude the basement from the interior volume calculation if it is not finished when the house is first constructed and to recalculate the volume at such time as it becomes

finished space.[11] Some experts, however, disagree with this approach and feel that the basement should always be included in the calculation whether finished or not.

Rationale

In dealing with the issue of mechanical ventilation, the Associate Committee examined the activities of similar organizations such as ASHRAE, of other countries such as Sweden, and of other sectors such as the mobile home industry.

The rate of 0.5 air changes per hour was chosen as being a figure regarded as reasonable, both for health concerns and moisture removal, by experts both at home and abroad.

Although the figure of 0.5 ach is generally regarded as acceptable, it is only a guess as far as air pollutant removal is concerned. According to a recent Swedish study cited in the June 1985 issue of Energy Design Update,

> "a fresh air input of 0.2 to 0.5 air changes per hour may be adequate for good air quality in new airtight, timberframe houses, as long as the mechanical ventilation system is properly designed with well-balanced air flow to each room. Only in dwellings with radon problems . . . would 0.5 air changes per hour or more be generally necessary."[12]

Not all researchers agree with this conclusion. They point out that 0.5 ach is irrelevant if a strong pollution source remains either inside the house or in the path of the incoming fresh air supply.

The Associate Committee chose not to prescribe a flow rate in litres per second as used by ASHRAE and throughout much of Europe. Instead they used an air change rate because they felt Canadians were more familiar with that concept.[13] Another reason could be simply that the 1980 NBC called for mechanical ventilation in terms of an air change rate.

The impetus for the new mechanical air change requirement came from the need to control humidity in the new generation of more tightly built housing, and not from a concern for indoor air quality. Although the committee was aware of other air quality implications, they were convinced that humidity control was the overriding factor in housing in Canada.[14] There is still some discussion among the research community as to which control strategy will prove to be the most effective and the most trouble-free for non-technical home-owners.

To keep the requirement relatively simple, the committee agreed to allow either manual or automatic control, with no stipulation on what type of control to use.

The need to control humidity had first been perceived with the widespread use in the 1960's of electric heating, which led to the requirement for an exhaust fan in such houses. With the new requirement for mechanical ventilation in all houses, that heat-source-specific requirement is no longer in the code.

Status

The Associate Committee on the NBC has already met to clear up unfinished business and to begin discussions on the next edition of the code, due in 1990. Ventilation is not considered a controversial area, although ventilation issues are being considered, with primary focus on air quality including formaldehyde problems.

4.4 Responsibility for Code Compliance

Uncertainty exists as to who is finally responsible for complying with the requirements of the building code.

NRC publishes a supplementary document, called Administrative Requirements for Use with the National Building Code. It clearly lists the responsibilities of

owners, designers, architects and inspectors. Under these suggested guidelines, which like the NBC are a model that must be officially adopted to have legal force, the owner has the ultimate responsibility to construct his building in conformance with the building code. Under provincial Architects and Engineers Acts, designers bear professional responsibility for ensuring that their work conforms to local requirements as well.[15]

For years there has been discussion about removing all administrative guidelines from the NBC, making it a purely technical document. However, some pseudo-administrative requirements are still contained in Section 2. Many jurisdictions have elected not to adopt Section 2 in preference to their own established practices. Most municipalities interviewed during this study indicated that they consider the designer to be the person responsible for code compliance.

4.5 1983 Measures for Energy Conservation

Building codes are increasingly being used to achieve other objectives beyond the traditional concerns of health and safety. For example, most building codes, including the NBC, now contain requirements designed to make buildings more accessible to the disabled. Some provincial building codes now also contain requirements relating to energy conservation.

Background

During the preparation of the 1975 edition of the NBC, the Associate Committee had been specifically asked to consider energy standards and include thermal insulation requirements. However, it was concerned about a fragmented approach to energy conservation and whether the code should deal with more than health and safety issues.[16]

Energy requirements are not included within the NBC but have instead been released as a separate document,

Measures for Energy Conservation in New Buildings. The first edition was released in 1978. That document was based on ASHRAE Standard 90-75 Energy Conservation in New Building Design with modifications to suit Canadian conditions. The second, current edition was released in 1983 and was based on an updated ASHRAE standard, 90A-1980.

Measures provide a basis for improving the energy use characteristics of new buildings and are intended to be minimum requirements. The 1983 Measures contains a new, simplified chapter, Section 8, on houses with the same requirements in the other sections for buildings with low internal heat generation. Section 8 applies to detached, semi-detached, duplex and row houses.

Requirements

The 1983 Measures does not contain any requirements for ventilation in houses.

It covers maximum leakage requirements for windows, doors, and sliding glass doors and it also specifies the use of caulking or gaskets to seal the junction between sill plate and foundation and other possible leakage points in the exterior shell, but there are no ventilation requirements.

In the section on Heating, Cooling and Ventilating which applies to all occupancies including apartment suites but excluding houses, the one ventilation requirement applies only where mechanical ventilation is provided and it calls for controls allowing not more than the outdoor air quantities given in ASHRAE 62-81 where energy is required to heat or cool the outdoor air.[17] ASHRAE 62-81 requirements are explained more fully in Chapter 9 of this report.

In early 1983 Quebec adopted a code for energy conservation based on Measures, and both Alberta and Ontario have added requirements for minimum insulation levels to their provincial codes, although these appear not to be derived from Measures. The Ontario code also contains an additional section (9.39) based on Measures which can be used as an alternative to the mandatory insulation levels.

CHAPTER FOUR REFERENCES

1. Subscriptions to NBC/NFC News are available at no charge from the Codes and Standards Secretariat, Division of Building Research, National Research Council, Ottawa K1A 0A6, telephone (613) 993-9960.

2. For a discussion of the changing membership procedures when work on the 1985 NBC wrapped up in 1984 as well as a listing of the make-up of the various committees involved, see the February 1984 issue of NBC/NFC News, pages 1 and 2.

3. "Thank you Candidates," NBC/NFC News, No. 109, June 1985, page 4.

4. Interview with A.T. Hansen, former head of the technical section of NRC's Codes and Standards Group and a long-time technical advisor to the Associate Committee and several of the Standing Committees. Mr. Hansen supplied much of the background information relating to the development of the various versions of the codes.

5. Source: Builders' Bulletin, no. 220, August 2, 1972, Central Mortgage and Housing Corporation, Ottawa.

6. Source: Product literature for vanEE 2000 series air-to-air heat exchangers manufactured by Conservation Energy Systems Inc., 800 Spadina Ave., Box 8280, Saskatoon S7K 6C6 (306) 665-6030.

7. "Changes from the 1980 Edition," 1985 National Building Code, page viii.

8. Interview with Richard Desserud, Technical Advisor, Codes and Standards Branch, National Research Council, Ottawa.

9. Interview with Richard Desserud.

10. Interview with A.T. Hansen.

11. For more information, contact David Olivier, Open University, Walton Hall, Milton Keynes MK7 6AA England.

12. Interview with Richard Desserud.

13. Interview with Richard Desserud.

14. Interview with A.T. Hansen.

15. Dickens and Wilson, Energy Conservation and Building Regulations, reprinted from proceedings of First Canadian Building Congress 1976, DBR Paper 728, NRCC 16114, p. 204.

16. Section 5, Heating, Cooling and Ventilating, Article 5.2.1, Measures for Energy Conservation in New Buildings, 1983, National Research Council, Ottawa, soft cover, 45 pages, $2.

Under Canadian law, the regulation of building construction is the responsibility of provincial governments, which in turn can delegate this power to their municipalities.

Background

Prior to the 1970's, provinces generally delegated the responsibility of regulating buildings to municipalities. During the last decade, however, provincial codes began to replace municipal building bylaws. By early 1986 when Saskatchewan is expected to adopt the 1985 NBC as the base document for the provincial code, all provinces from Quebec west to British Columbia will have their own building code. Only the four Atlantic provinces rely on municipal bylaws to regulate building construction.

Most provinces now have provincial building codes based on the National Building Code and amended as necessary to reflect local conditions. In provinces without provincial building regulations, the NBC is invariably the basis for municipal building bylaws either by choice or as a requirement of the province.[1]

Liaison between the NBC and the provinces is maintained through a Provincial Advisory Committee on the National Building Code (PAC), as described earlier in Chapter 4. PAC has representatives from all ten provinces and the two territories.

Information on provincial building codes was obtained from ACNBC internal documents, interviews with PAC representatives or someone in the provincial building code office, and from the enabling legislation and the codes themselves. A list of all organizations contacted is included in the Appendix, along with a list of members of the Provincial Advisory Committee of the NBC.

5.1 Provinces with Building Codes

5.1.1 Quebec

Ventilation Requirements

The Quebec Building Code was modified in April 1984 and is now based on the 1980 National Building Code. The same residential ventilation requirements apply.

Status

The province is working toward adopting the 1985 NBC, although when this might take place is still uncertain.[2]

Energy Conservation in New Buildings

In 1983, Quebec adopted Règlement sur l'économie de l'energie dans les nouveaux bâtiments. Like Measures for Energy Conservation in New Buildings on which it is modelled, this document contains no ventilation requirements for single-family houses whether detached, semi-detached or in rows. Like Measures, it contains a chapter on Heating, Cooling and Ventilation which is oriented to large buildings excluding houses. Quebec is the only province that has adopted Measures.

5.1.2 Ontario

The current edition of the Ontario Building Code is 1983, based on the 1980 NBC with additional requirements, including an optional section for professional designers of custom houses.

Ventilation Requirements

The principal requirements of the Ontario Building Code are the same as those of the 1980 NBC. Thus, Ontario requires either natural ventilation with minimum

opening sizes by room type, or mechanical ventilation with a capability of at least one air change per hour.

The Ontario code also contains two additional chapters not found in the NBC -- Part 10 Building Requirements for Handicapped Persons and Part 11 Residential Renovation.

Part 11 was designed to assist in more effective and economical renovation of existing residential buildings, and the conversion of other existing buildings to residential use. It is intended to provide greater flexibility in meeting safety standards when renovating by removing code requirements intended for new construction to encourage renovation rather than demolition.[3] Part 11 contains no requirements relating to ventilation.

Part 9 of the Ontario Building Code also contains requirements and even entire sections not found in the NBC model. For example, Section 9.26 on Thermal Insulation and Vapour Barriers calls for specific insulation levels for different building components, ranging from RSI 5.64 for exposed ceilings, RSI 3.52 for exposed roofs and RSI 2.11 for exposed walls to RSI 1.41 for solid foundation walls and unheated slabs on grade.

Comparable requirements are not found in the NBC but in Measures for Energy Conservation, an NRC model document that Ontario has not adopted.

Additional sections cover Garages and Carports, Cottages and Log Construction.

Additional Requirements

The Ontario code contains additional ventilation requirements to those in the 1980 NBC. It calls for mechanically ventilated washrooms not served by self-contained systems in individual dwelling units to supply a minimum exhaust rate of not less than 1.42 m^3/min (24 L/s) for each toilet or urinal.

Section 9.34 Heating and Air-Conditioning specifically requires that any repairs, adjustments or component replacements that change the capacity or safety of existing heating, ventilating or cooling equipment or that alter the method of operation must conform to the code. The NBC contains no comparable requirement.

The Ontario Building Code also lists specific titles and dates of various engineering publications that constitute "good engineering practice."

Optional Requirements

The Ontario code contains Section 9.39 Thermal Design, an optional section which can be used as an alternative to the thermal insulation requirements of Section 9.26 if the design is provided by an architect or professional engineer.

1983 Ontario Building Code

SECTION 9.39 THERMAL DESIGN

Subsection 9.39.1. Scope

9.39.1.1.(1) This Section applies to the thermal design of a building of residential occupancy where such design

(a) is an alternative to the thermal insulation requirements of Section 9.26, and

(b) is provided by an architect or a professional engineer.

Subsection 9.39.2. General

9.39.2.1. The materials for, and the installation of, thermal insulation and vapour barrier protection shall conform to Section 9.26.

9.39.2.2. Foamed plastic thermal insulation shall be protected in conformance with Section 9.30.

9.39.2.3. Crawl spaces shall comply to Section 9.18.

9.39.2.4. Roof spaces shall comply to Section 9.19.

9.39.2.5. Ventilation requirements shall comply to Section 9.33 except as provided in Subsection 9.39.7.

9.39.2.6. Heating and air conditioning requirements shall comply to Section 9.34.

Subsection 9.39.7. Ventilation

9.39.7.1. Fresh air for the ventilation of rooms and spaces in buildings of residential occupancy shall be provided at a rate of at least 0.5 air change per hour by a combination of natural and mechanical ventilation.

These optional requirements are intended to allow for innovation in custom housing. If the designer chooses to use this section, the following requirement applies instead of the basic natural or mechanical ventilation rules:

Fresh air for the ventilation must be provided at a rate of at least 0.5 air changes per hour by a combination of natural and mechanical ventilation.

[1983 OBC: 9.39.7.1.]

Note that the Ontario code says that "fresh air must be provided," whereas the new NBC says that dwelling units must have a mechanical system "capable of providing ...." In other words, the NBC doesn't require fresh air, just the capability to provide it.

Rationale

According to a mechanical engineer with the Ontario Buildings Branch, the optional requirement for 0.5 ach of fresh air was included to cover custom houses with greater degrees of airtightness than standard construction.

The term "fresh air" means air from the outdoors. The basic mechanical ventilation requirement in the Ontario code, as in the NBC, simply calls for a specified air change rate with no mention of where the replacement air comes from. If only an exhaust fan is used, the replacement air will be drawn from the rest of the house where it will be replaced by leakage from outside.

With this optional requirement in the Ontario code, all rooms are required to have 0.5 ach with outdoor air actually provided.

According to the spokesman, the figure of 0.5 was selected after reviewing requirements in other countries, notably Sweden, and was regarded as adequate to control indoor humidity and air quality. This requirement is completely separate from that for combustion air supply.

Status

The current Ontario Building Code was adopted in 1983 and amended in 1984. The 1985 NBC is being examined by officials and a new provincial code based on that model is expected to be drafted, available for public review, finalized, approved and in place in early 1986.

Ventilation Task Force

Ontario is also in the process of establishing a Task Force on Ventilation Requirements, Air Quality and Condensation charged with drafting a new ventilation standard to cover all building occupancies.

The Task Force will begin by examining the issues raised in a recent series of bulletins issued by the Ontario New Home Warranty Program concerning possible risks associated with airtight residential construction.[4] The Task Force will also consider the issue of indoor contaminant levels.

Initial plans called for the Task Force to have a draft standard in circulation for review during the fall of 1985, with a finalized standard in force by the end of the year.[5] Since then however, the deadline for the first step, the draft standard, has been extended to March 31, 1986.

While the planned schedule for the Task Force may be optimistic, it appears likely that sometime during 1986 Ontario will have more restrictive ventilation requirements than those currently required by the 1983 provincial building code, and probably more detailed and specific than the 1985 NBC requirements.

5.1.3 Manitoba

Ventilation Requirements

The Manitoba Building Code was adopted in 1981, is based on the 1980 National Building Code, and the same basic ventilation requirements apply.

Status

The 1985 National Building Code is currently under review in Manitoba and is expected to replace the 1980 version in January 1986.

5.1.4 Alberta

Alberta became the first jurisdiction to officially adopt the 1985 National Building Code, with additional ventilation requirements of its own, as the Alberta Building Code 1985.

The earlier 1981 Alberta Building Code was based in the 1980 NBC with several more detailed ventilation requirements. These same requirements have been carried forward to the new Alberta code. The 1985 Alberta code also covers certain buildings not covered by the NBC, specifically log buildings and relocatable industrial housing used in work camps. It covers building access for the handicapped and for energy conservation in residential buildings stipulates minimum thermal insulation values.

Additional Requirements

A copy of the full ventilation section of the 1985 Alberta code, including the additional requirements marked with asterisks in the margin, is included in the Appendix. The following paragraphs summarize the additional requirements.

If roughed-in plumbing is installed for the future installation of a toilet or urinal, provision must be made for the required ventilation [Article 9.33.1.7]. This requirement means that either the natural ventilation (window) or mechanical ventilation (bathroom exhaust fan) must be installed so that the room will meet the requirements if finished later without benefit of permit or inspection.

Fireplaces, both site-built and factory-prefabricated, are considered as fuel-fired appliances [Article 9.33.1.8]. This requirement means that fireplaces in Alberta must be supplied with combustion air, either with a direct duct to the outdoors or a duct connecting to the basement where all gas furnaces are required to have a combustion air supply duct to the outdoors.

Prior to the release of the 1985 NBC, Alberta was the only province to require a fresh air supply for houses. That fresh air requirement continues in the Alberta Building Code 1985:

Alberta Building Code 1985

* 9.33.1.9. A supply of fresh air shall be provided for a residential occupancy and, if the building is heated by a forced air system, may be introduced at the return air duct upstream from the furnace fan.

* 9.33.1.10.(1) An outdoor air intake opening 0.008 m² or less in area into a return air system shall not be dampered.

* 9.33.1.10.(2) An outdoor air intake opening more than 0.008 m² in area but less than 0.033 m² in area into a return air system shall be equipped with a manually operated 50% damper.

* 9.33.1.10.(3) An outdoor air intake opening not less than 0.033 m² in area into a return air system shall be equipped with an automatic damper.

* 9.33.1.11. If a ventilating system exhausts air to the outdoors, provision shall be made for the admission of a supply of make-up air in sufficient quantity so that the efficiency of the exhaust system is not adversely affected.

The Alberta Department of Labour's Building Standards Branch produces a series of Standata technical bulletins which offer official interpretations of code requirements, but no such document has been released to explain the department's stand on the fresh air supply requirement.

An official with the Building Standards Branch explains that the inspectors usually look for a system that will supply a minimum of 0.5 ach. Thus in the case of forced air furnaces, installers use the appropriate fresh air duct size dampered according to the requirements. In the case of the relatively few hydronic heating systems in Alberta, a mechanical exhaust vent is required.[6]

Although this fresh air requirement is specifically separate from any combustion air requirements, the two can be handled jointly, according to a May 1984 Standata dealing with combustion air for residential gas furnaces. That bulletin gave two approved methods for providing combustion and ventilation air. The first method allows a common duct from the exterior to the return air duct, sized to meet both sets of requirements. The second method permits a ventilation duct connected to the return duct plus a separate open-ended combustion air duct in the vicinity of the furnace. A photocopy of that Standata is included in the Appendix.

The Alberta Building Code also requires that clothes dryer vents be ducted to the outside. No screens are permitted on these vents and access doors for cleaning are required. These vents cannot be connected to other exhaust systems, to gas vents or to chimneys.

5.1.5 British Columbia

The 1980 National Building Code was adopted as the British Columbia Building Code in 1981 and the same residential ventilation requirements apply.

Parts 1 to 6 plus Part 9 were adopted intact. Part 7 was not adopted as the province has its own plumbing code. The B.C. code contains Section 3.7, Building Requirements for Persons with Disabilities, which is more rigorous than the national model.

Status

The proposed changes for the 1985 National Building Code were circulated for public comment during the fall and winter of 1984-85. A series of open seminars were also held. It is anticipated that the 1985 NBC will be adopted in October 1985, or possibly not until early 1986.

5.2 Provinces without Building Codes

5.2.1 Newfoundland

Newfoundland has no provincial building code, but municipalities are required to have their own set of building regulations which have to be approved by the Minister of Municipal Affairs. An official copy of the 1980 National Building Code signed by the minister is kept on file in St. John's and it is departmental policy that municipalities adopt the National Building Code and the National Fire Code.

Ventilation Requirements

Some 248 of the 306 municipalities -- which includes all the major population centres -- have adopted the 1980 NBC, and so those basic ventilation requirements apply.

These 248 municipalities have a total population of 451,616 (according to the 1981 census), while the 58 municipalities that have not yet adopted the NBC have a combined population of only 35,428. So, almost 93 percent of those living in incorporated areas in Newfoundland are subject to the provisions of the National Building Code.

There appears to be some resistance to the document in the smaller municipalities in Newfoundland where it is perceived to be too complicated and the standards too expensive to maintain. Another factor may be the cost of the code documents themselves, with a price tag of $57.50 a set.

The provincial Department of Public Works has adopted the NBC for all buildings under its jurisdiction. The Newfoundland Fire Prevention Regulations of 1982 also require that all construction, alteration or reconstruction of buildings -- except for one and two family dwellings -- must comply with the latest edition of the National Building Code.

Status

The provincial Department of Municipal Affairs is expected to "adopt" the 1985 National Building Code as the reference document for the municipalities.

5.2.2 Prince Edward Island

P.E.I. has no building code although the provincial government has the authority to pass new building regulations. Only two municipalities have their own building codes -- Charlottetown and Summerside, both of which use the 1980 National Building Code.

The P.E.I. Department of Public Works also uses the 1980 NBC for buildings under its jurisdiction. The province is covered by the National Fire, Plumbing and Electrical Codes plus a Development Control Code which deals with zoning. CMHC's Residential Standards, based on the 1980 NBC, are used for all projects in the province funded under the National Housing Act.

5.2.3 Nova Scotia

Legislation in the form of an act to establish a provincial building code received royal assent in the legislature in 1977 but has never been proclaimed. Approximately 50 of the province's 66 municipalities have voluntarily adopted the 1980 NBC and it is anticipated that they will eventually adopt the 1985 version.

5.2.4 New Brunswick

Although municipalities are not required to have a building code, any that do have building regulations

have been required since 1980 to adopt the 1980 National Building Code. Some 104 of 114 municipalities have adopted the 1980 NBC.

The province has already unofficially "adopted" the 1985 NBC which means that it is thereby adopted by those municipalities previously using the 1980 version.

Those areas of New Brunswick under direct provincial administration must also use the National Building Code.

5.2.5 Saskatchewan

Saskatchewan currently has no provincial building code. The 1980 NBC is the code of reference adopted by most of the major population centres, although a few have already adopted the 1985 NBC.

However, many municipalities, particularly the smaller ones, still use earlier versions of the NBC, some dating back to the 1960's. The split appears to be about even, with one-third of the municipalities using the 1980 NBC, one-third using 1970, 1975 or 1977 versions, and the remaining one-third using even earlier versions. The apparent cause of this diversity stems from the fact that urban, rural and northern municipalities fall under different provincial legislation.

Status

Legislation is being prepared to adopt the 1985 NBC as the provincial code with a target date of April 1986. The enabling legislation, as currently written, will not void local codes or other provincial legislation.

A proposal for standardization is being drafted and, if accepted, it could see a major overhaul of the existing system. It seems likely that it will take some

time before the provincial code based on the 1985 NBC will be fully in effect in other than the major municipalities.

5.3 Territories

5.3.1 Yukon

The Building Standards Ordinance establishes the current version of the NBC as the territorial standard governing all areas outside the eight municipalities, with automatic adoption of revised versions. A major amendment to the Municipalities Act in 1984 stipulated that municipalities must adopt the current NBC. This regulation applies to eight incorporated municipalities. More stringent requirements may be added, subject to Ministerial approval.

The 1980 NBC is presently in effect in the Yukon and the 1985 version will take its place on August 1, 1985, after the required public notices are published.

5.3.2 Northwest Territories

The Fire Prevention Ordinance specifies that the latest edition of the NBC is to be in force for all buildings throughout the NWT.

The 1980 NBC is currently in effect, with the adoption of the 1985 version scheduled for January 1, 1986, after announcements have been published and bulletins sent out to the building community.

CHAPTER FIVE NOTES

1. A.T. Hansen, "The Regulation of Building Construction," Canadian Building Digest No. 237. A photocopy is included in the Appendix.

2. Interview with Luc St. Martin, NRC's technical advisor on the NBC charged with liaison with Quebec.

3. Source: Residential Renovation, Part 11 of the Building Code, Ministry of Municipal Affairs and Housing, Toronto, August 1984, a 20-page booklet prepared for general information purposes only and not for specific interpretations.

4. A brief discussion of the controversy can be found in Chapter 7. A photocopy of Bulletin 13 which established the requirements ending the controversy is included in the Appendix.

5. Interview with David Hodgson, Director, Ontario Buildings Branch, Ministry of Municipal Affairs and Housing.

6. Interview with Dick Massiah, Associate Director of Field Services, Building Standards Branch, General Safety Services Division, Alberta Labour. Telephone (403) 427-8265.

The people who ultimately interpret the building code are the building inspectors, the municipal officials who check the plans, issue the permits and walk onto the job site, checking that plans are being followed and regulations obeyed.

The volume of work must be huge; last year in Ontario alone 120,000 building permits were issued while CMHC performs some 280,000 inspections a year across the country.

Associations

All ten Canadian provinces have provincial associations of building officials. Combined membership in provincial associations totals about 2,650 members.

At the national level, the Canadian Building Officials Association, representing about 350 members, is constituted as a council, with representatives of the provincial associations, the territories, and certain national agencies, specifically the National Research Council's Associate Committee on the NBC. A quarterly news journal is published.[1] A national Building Safety week is proposed for local proclamation. A joint conference of the national and Ontario organizations was held in October 1985.[2]

Lists of names and addresses for national and provincial associations are provided in the Appendix.

At the international level there is a World Organization of Building Officials, formed in 1984 in Saskatoon. A World Congress of Building Officials is planned for 1987 in London, co-organized by the Incorporated Associations of Architects and Surveyors of England.

Information for this chapter was obtained through telephone interviews with building code officials in

all ten provinces, two territories and seven cities selected to provide a range of geographic and administrative coverage. Information on enforcement of CMHC's Residential Standards is provided in Chapter 7.

6.1 Provinces with Building Codes

6.1.1 Quebec

Scope

The Ministère de l'Habitation et de la Protection du Consommateur is responsible for the building code, which applies throughout the province to new construction of public, industrial, commercial and apartment buildings over two storeys high and containing more than eight units.

The ministry has no jurisdiction over low-rise housing although the provincial code does contain Part 9 Housing and Small Buildings. It is not clear why this distinction is made, but it may be related to the requirement that buildings larger than house size must be designed by an architect or engineer.

Enforcement

Responsibility for enforcing the building code is assigned to municipalities, with assistance from the province if requested, except for houses.

Thus, in the province of Quebec, enforcement for residential building regulations is solely in the hands of the municipalities.

Municipalities may adopt their own building code or use the provincial code, but it must be at least as stringent as the provincial code. An estimated 20 percent of municipalities have their own code, including the city of Montreal.

6.1.2 Ontario

Enabling Legislation

The current Ontario Building Code came into effect on November 30, 1983, with proclamation of the Building Code Act.

Prior to 1983, the Ontario code was administered by the Ministry of Consumer and Commercial Relations, but just before the new code was adopted, responsibility was transferred to the Ministry of Municipal Affairs and Housing. The code is administered by the Ontario Buildings Branch, consists of three sections --- Technical Standards, Policy and Municipal Building Administration.

Scope

Under the terms of the Building Code Act, municipalities (or counties with the agreement of one or more municipalities) are required to enforce the code in their jurisdictions under a chief building official. The necessary apparatus for permits, fees, requirements and inspections is spelled out and the powers and limitations of the municipalities and its inspectors are specified. The Director of the Building Code Branch serves as the chief building official for the province with responsibility for areas without municipal organization.

Appeals

The chief building official at the municipal and provincial level can review and amend any inspector's decision. Decisions by building officials and inspectors can be appealed in county or district court which in turn can be appealed at the Divisional court level.

The Lieutenant Governor appoints a Building Code Commission (no members of which can be provincial or municipal employees) to resolve disputes over technical issues. The commission's decision cannot be appealed.

Training

In the past, the province has offered little formal training for municipal inspectors, relying on periodic newsletters[3] and having its advisors visit locally and

attend meetings of such groups as the property standards inspectors, plumbing inspectors and building inspectors.

Some inspector training courses have been offered by the Ontario Building Officials Association and similar courses have been held in Metro Toronto. The Fire Safety Association has also offered training courses.

Under the Ontario Buildings Branch, the three-man municipal administration section has established a Municipal Inspectors Training and Education Council, made up of the various trade associations. A Building Action Program has been started and a series of two-week training seminars called "Inspector in the House" were held in early 1985 in six different cities. A second series is planned for late 1985.

A more intensive one-week seminar for plumbing inspectors will have a pilot run in 1985 and another one-week course covering legal matters is scheduled for early 1986. The courses are publicized with mass mailings and by the code advisors as they make the rounds in their territories. Grants are available under the program for municipalities to improve administrative procedures and to train their inspectors at the provincial seminars.

The Ontario Buildings Branch is also preparing a new document, Guide and Illustrations for Part 9 of the Ontario Building Code, intended to assist in the interpretation and application of code requirements that are "complex or not fully understood." It is now available from the Ontario Government Bookstore.[4]

The Ministry of Municipal Affairs and Housing also provides some public information, mostly directed to homeowners considering renovation, including a 36-page booklet called Plans, Permits and Payments. It contains practical advice covering design issues and contracting, and reviewing the permit/inspection process.[5]

6.1.3 Manitoba

Enabling Legislation

The Manitoba Building Code was adopted under the Buildings and Mobile Home Act in 1981 and is administered by the provincial Fire Commissioner in the Department of Labour and Employment Services.

Scope

The Manitoba code covers the entire province. Municipalities administer the Part 9 housing requirements. Permits and inspections are done on a local basis except for public buildings and hospitals, which fall under the auspices of the Provincial Fire Commissioner.

Under the City of Winnipeg Act, Winnipeg administers the entire code within its jurisdiction. The Deputy Director of Environmental Planning for Winnipeg is the current chairman of the Part 9 Committee on the Manitoba Building Code.

Appeals

Appeals to decisions made under the Manitoba Building Code are made to the Minister of Labour who may refer the appeal to the Manitoba Building Standards Board for advice. The final level of appeal to the decision of the minister is to the Court of Queen's Bench.

Inspector Training

There is no official program for inspector training, although a correspondence course is run by the Manitoba Fire College in Brandon.

6.1.4 Alberta

Enabling Legislation

The Alberta Uniform Building Standards Act dates from 1974.

Scope

The Alberta Building Regulation, with amendments, provides most municipalities with legislative authority to enforce the Alberta Building Code, to write building permit bylaws and to appoint inspectors. Permits and inspections are not mandatory, but if they are instituted they must comply with the regulations. Neither inspectors nor municipalities can accept less than the code standards, nor are they allowed to stipulate higher standards. Building owners, however, may voluntarily exceed code requirements.

Training

The Alberta Building Code falls under the jurisdiction of the Department of Labour's General Safety Services Division which runs substantial correspondence courses plus seminars and examinations through the Building Standards Branch training section.

Standata bulletins are issued frequently to provide explanation and interpretation of code requirements and to provide rulings on specific issues. A similar series of Standata product listings is distributed which describe materials and products which have been judged acceptable to meet specific code requirements. Such a Standata has been issued for a motorized combustion air duct damper, for example, although none so far have been issued for approved ventilation systems.

Enforcement

Although the new requirements for a 0.5 air change rate during the heating season are already in effect, provincial authorities have no idea how local inspectors will enforce them. The Building Code Branch will probably issue a Standata, perhaps with guidelines on fan capacities for several ranges of interior volume, although the issue has still not been examined.

Appeals

If an owner considers that an order made by an inspector is not valid he may initiate an appeal to the Alberta Building Standards Council, an independent quasi-judicial body whose rulings are binding. The owner must notify the Director of the Building Standards Branch of his intention to appeal within 15 days of the inspector's order.

6.1.5 British Columbia

Scope

The B.C. Ministry of Municipal Affairs has responsibility for the British Columbia Building Code. Local authorities administer the code, issue permits and do inspections. They cannot, however, make any changes or amendments to the code.

Training

Four years ago the Ministry instituted an Inspector Training Program, since cut by fiscal restraint programs. Now, the B.C. Building Association runs its own program. Bulletins are issued on occasion. The Ministry's Building Standards Branch maintains a Technical Advisory Service.

Inspectors do not get involved in fresh air issues, although independent contractors are available on call by inspectors if compliance becomes an issue. Normal procedure is for inspectors to check fan capacity only. Inspection procedures tend to be more sophisticated in the cities and much less so in rural and remote areas. Regional districts in the north of province do not apply the provincial building code. The Fire Commissioner's Office, however, does cover the entire province.

Appeals

The B.C. Building Code Appeal Board provides the highest level of appeal. Its decisions are legally binding. Below that are written Branch approvals and verbal communication with Branch advisory personnel.

Renovations

Whether or not a renovation or equipment retrofit requires a building permit and inspections depends on the extent of the work and on the judgment of local authorities. Although the B.C. Building Code does specify that renovations are covered, the definitions are considered sufficiently vague to allow local interpretation.

Enforcement

Concern has been expressed that the trend to more precise air change regulations are increasingly difficult to monitor and enforce. Inspectors will be expected to enforce the 0.5 ach requirement, although it is not clear how. Generally airtight, low-energy buildings are not a concern in British Columbia as the climate does not encourage that type of construction.

6.2 Provinces without Building Codes

6.2.1 Newfoundland

The Municipalities Act requires every local council to have building regulations and every builder to secure a permit from the council. According to a spokesman for the provincial Department of Municipal Affairs, few municipalities in Newfoundland have qualified inspectors. The province provides no formal training and supplies no technical bulletins or newsletters, although advice is provided when possible. Inspections are done by CMHC and the Newfoundland and Labrador Housing Corporation on buildings under their jurisdiction.

Municipalities issue building permits, with some inspections only in urban areas. Administration varies. There is no appeal process.

The only applications for a building permit that a municipal council can approve without referral to the Fire Commissioner are those for one and two family dwellings, which must comply with the provisions of both the National Building Code and the National Fire Code. All other applications must be referred to the Fire Commissioner by the municipality, together with a Fire Commissioner's National Building Code data form plus the plans and specifications as required by Part 2 of the NBC. The data form requires specific information on heating, ventilating and air-conditioning. No permit to build may be issued by a municipal council until approval in writing has been received from the Fire Commissioner, confirming that the proposed

building meets the requirements of the National Building Code, the National Fire Code, and the Life Safety Code.

The Fire Code requirements are emphasized and extensive non-residential inspection is maintained. The Fire Commissioner covers all buildings larger than one or two unit residential buildings.

6.2.2 Prince Edward Island

The provincial Department of Municipal Affairs supplies some advice to local authorities, but the cities have their own staff with no provincial involvement. Some city inspectors have taken training courses in Nova Scotia.

The provincial Building Association runs courses and a Building Construction Technology course is offered by Holland College of Applied Technology in Charlottetown.

A Home Warranty Program exists under the P.E.I. Construction Association and inspections are provided, if requested. That organization can also hold hearings and listen to appeals.

6.2.3 Nova Scotia

The provincial Department of Municipal Affairs assumes no responsibility for technical advice or interpretation, leaving that to the individual municipalities. However, the province does run two courses a year under the Municipal Training Services section, involving both new personnel and experienced inspectors, responding

to needs perceived by the department and the provincial Building Officials Association.

Not many inspectors are involved in large complex buildings. The Fire Marshall inspects all buildings larger than single and double family residences.

6.2.4 New Brunswick

Municipalities are empowered to enforce their own version of the 1980 NBC by issuing permits and performing inspections. Inspector training is done by the N.B.-Department of Labour and Human Resources, which also manages Fire Marshall and electrical inspector training. Upgrading is the responsibility of the individual municipalities. Legal advice is provided by the province, but no interpretation. There is no appeal process in place.

6.2.5 Saskatchewan

According to the province's chief building inspector, administration of building regulations is a patchwork of different approaches. Some municipalities issue permits, others have bylaws and no permits, many have no inspectors. The twelve cities in the province have their own inspectors, but inspection is sporadic as the volume of construction is small. Inspections are done by CMHC and the Saskatchewan Housing Corporation on buildings under their jurisdiction.

There are no provincial inspector training programs or technical information transfer mechanisms. Appeals are handled at the local level.

6.3 Territories

6.3.1 Northwest Territories

Yellowknife is the only local jurisdiction with building inspectors. No formal training system is in place. Municipalities control development permits and provide electrical and mechanical approvals. The Fire Marshall approves construction in all outlying areas.

6.3.2 Yukon

Whitehorse has three building inspectors who have been trained by the territorial government. The city issues permits and carries out inspections. Technical bulletins are sent out by the Fire Marshall's office as needed to update local officials.

The structure is in place for an Appeals Board but it has never been convened.

Mobile homes are a problem area for code officials. In the past, mobile homes have been permitted with CSA Z240 certification where zoning permitted. However, the Building Standards Act permits non-CSA Z240 units in such places as mining camps. Problems arise when these units are relocated and the issue has become political. An amendment now before Cabinet recommends that approval be given to mobile homes without inspection except for foundations and electrical connections. The increased use of non-certified mobile home units apparently came as a result of the economic downturn that closed the mines. They were seen as affordable, alternative housing looked upon as permanent dwellings.

6.4 Selected Major Municipalities

Seven Canadian cities were surveyed to determine how ventilation requirements are being interpreted and enforced. The cities chosen were Halifax, Montreal, Ottawa, Toronto, Winnipeg, Saskatoon and Vancouver, a selection based on geographic coverage and types of code jurisdiction.

Enforcement

Building codes in each municipality are virtually identical to the 1980 National Building Code. Departmental activity is essentially similar. Each jurisdiction inspects plans, issues permits, performs inspections. Inspection frequencies vary in response to workload and available personnel. One city performs only spot-checks. Ventilation provisions are generally reviewed at the plan-check stage, where window openings are checked against floor dimensions and are approved for fire-safety egress. Some municipalities check mechanical ventilation on site, generally in the form of inspection of ductwork and fan function. Experienced inspectors rely on their own judgement of what seems reasonable from their experience.

No cities indicated that air change calculations are made, either during plan review or on-site. Several indicated that the responsibility for adequate ventilation falls squarely on the building's designer, making the municipality's function one of a watchdog. Most indicated that a lot of renovation goes on without benefit of permits and slips through the system unmonitored. Some cities have specialized inspectors dealing with plumbing or heating. Electrical inspection of the mechanical ventilation system is usually performed by the electric utility.

No municipality indicated any local amendments or interpretations affecting ventilation requirements. Compliance is claimed to be high, according to those interviewed. Disputes over code rulings rarely occur because, they say, the rules are clearly written and strictly enforced.

Training

Inspectors are typically older tradesmen with on-site experience. New inspectors are required to have post-secondary training in building technology. Most cities have civil or mechanical engineers on staff to handle more technical issues. Inspector training varies. Most cities indicated that in-house, on-the-job training and problem-solving is the common practice.

Most officials contacted were unaware of the new requirement in the 1985 NBC for 0.5 ach during the heating season. The typical response was a pragmatic, "We'll enforce it," but they did not know how. Most are not concerned with any changes until they go into effect in their own jurisdiction.

Summary

The sense across the country is that ventilation is not a major concern with local authorities, an opinion confirmed by spot-checks with several designers and builders in Ontario.[6] None of this group was aware, for example, of the 1980 code's requirement for mechanical exhaust in electrically heated houses and all expressed a view that they specified or bought kitchen and bathroom exhaust fans on the basis of cost and appearance rather than on capacity. They doubted that City Hall had the time or personnel capable of checking mechanical ventilation specifications. An adversarial relationship seems to exist between inspectors on one side and contractors and designers on the other, although building inspectors consider the relationship to be similar to policeman/citizen or teacher/student.

6.4.1 Halifax

Requirements

The City of Halifax adopted the 1980 NBC under City Ordinance 131. The municipal building code is administered by the Building Inspection Division of the Development Department, which adheres closely to Part 2 of the NBC --plans are reviewed, permits issued and inspections performed. Interpretation is strict, according to the Building Inspector Supervisor -- if a plan does not meet the code, it is simply not accepted. Occupancy permits are only issued after code requirements are met on site. Any disputes are referred

to the Nova Scotia representative on the NBC's Provincial Advisory Committee.

Scope

Responsibility to provide adequate ventilation is deemed to be the responsibility of the designer; the city considers itself to be just the watchdog. Any building valued at over $60,000 must be designed by a professional. Drawings are checked at the plan-approval stage; on-site inspectors check for fan ratings and ductwork.

Municipal officials have reviewed the 1985 edition of the National Building Code but have no comment on the new ventilation requirements. Residential ventilation does not appear to be an issue.

Renovations

Any renovation valued at over $500 is regulated by permit and inspections. Halifax has its own municipal standards for renovations, based on CMHC's Residential Rehabilitation Standards.

Training

Inspectors are usually professional tradesmen, carpenters and plumbers with extensive field experience. Twelve inspectors have attended courses held by provincial authorities in Halifax.

Mobile Homes

Halifax has only two mobile home parks. All units must be CSA Z240 approved. Because occupancy permits are not required the city does not have the leverage it has with new houses and no inspections are authorized or carried out.

6.4.2 Montreal

Requirements

Montreal has its own building code, originally dating from 1900 but now substantially similar to the 1980 NBC, including its lighting and ventilation requirements

(1 ach for mechanical ventilation). The code is enforced by the city's Permit and Inspection Department.

Scope

The Montreal code governs alterations requiring structural changes and new construction. It requires that two copies of the plans must be submitted for engineering and structural review. Ventilation plans are not asked for specifically. Plans must also pass zoning and fire regulations. Permits are issued after plan approval and any required corrections signed by the builder. An inspector visits the site every month during new construction -- every three months for small repairs. Code compliance is required for an occupancy permit. Residential enforcement is unofficially estimated at 90 percent.

Training

All city inspectors have long experience in building as contractors. New inspectors are now required to have a CEGEP (community college) diploma in architecture or engineering. Some in-house training is done and problems are worked out between inspectors, the supervisor and engineering staff. The department is the final authority.

Mobile Homes

Mobile homes are not permitted within the city.

6.4.3 Ottawa

Requirements

The City of Ottawa operates under the Ontario Building Code and follows its administrative procedures.

Scope

All plans for intended work are reviewed for architectural and mechanical soundness. Commercial buildings require a professional designer; houses up to 557 m^2 (6,000 square feet) do not require a professional. Ventilation provisions are checked at the plan-approval stage but in the field only fans are checked for function. Occupancy permits can be held up until

compliance is complete. Structural changes and repairs require a permit, but much renovation is done on the quiet and therefore is not inspected.

Training

Inspectors take code-related courses offered by the city and attend seminars held under the provincial Building Code Branch's Building Action program.

Appeals

Disputes are settled in the department by the chief building official and may be referred to the provincial Building Code Branch in Toronto.

Mobile Homes

Zoning regulations do not allow mobile home parks within Ottawa.

6.4.4 Toronto

Requirements

The City of Toronto operates under the Ontario Building Code, under the jurisdiction of the Buildings and Inspection Department.

Scope

New construction and renovations involving structural changes require a permit. The city reviews plans, issues permits and performs inspections. Plans are checked for ventilation ducts and fans. Inspections are carried out during stages of construction.

According to an inspector who asked not to be identified, bathroom and kitchen fans are checked to see "if they have reasonable capacities," but no calculations are made.

Appeals

The city's Building Commissioner insists that compliance with code requirements is 100 per cent and that there

is no reason for disputes and appeals as the standards are strictly observed.

Training

There have been several in-house training programs, including a "General Property Inspector" series for the past two years. Toronto has specialty inspectors covering such fields as plumbing and heating, but these are not generally involved at the residential level.

Mobile Homes

There are no mobile home parks in Toronto.

6.4.5 Winnipeg

Requirements

The City of Winnipeg Building By-Law is based on the Manitoba Building Code (the 1980 National Building Code with amendments).

Scope

Plans are submitted to the Building Inspection Division of the Department of Environmental Planning. Building, mechanical, and electrical inspections are carried out on new construction. The frequency of these inspections varies with workload and type of inspection. The extent of inspection on mechanical ventilation systems in housing consists of verifying that a mechanical system is installed in windowless bathrooms.

Training

Most of the city's 14 inspectors are former tradesmen, former construction supervisors or civil engineers. The city has its own internal training program and code review process.

Appeals

Internal rulings go to the Supervisor of Building Inspectors. Beyond that, the provincial Building Standards Board can be involved.

Mobile Homes

Mobile homes fall under provincial jurisdiction and are permitted only on the outskirts of the city. They are inspected only randomly. CSA Z240 certification is required.

6.4.6 Saskatoon

Requirements

The City of Saskatoon uses the 1980 NBC under the provincial Urban Municipalities Act.

Scope

Plans are reviewed by the Code Enforcement and Design Section of the Building Department for adequate natural ventilation -- windows are sized. Mechanical ventilation fans are checked for rating and function. The main concern is for fire safety. All residential construction projects valued at over $75,000 must have professional input, with the exception of one and two unit family dwellings. Responsibility for code compliance falls on the designer. No detailed calculations are made, but fans are checked for installation and function. Make-up air and ductwork for gas-fired furnaces are closely checked during construction. There are additional requirements for thermal insulation -- which are not specified in the NBC. Inspectors use CMHC's Residential Standards.

No problems are foreseen with the new code requirement for 0.5 ach during the heating season. Inspectors are familiar with mechanical ventilation systems as Saskatoon's low-energy houses are already equipped with air-to-air heat exchangers.

Renovations

Most renovations fall outside the city's jurisdiction where they are generally administered by the province in conjunction with CMHC's Neighbourhood Improvement Program and the Residential Rehabilitation Assistance Program.

Training

All Saskatoon inspectors are journeymen tradesmen with five to eight years experience. Discussions

about training programs have been going on with local colleges and the Saskatoon Association of Building Officials for ten years with no result. Funding is always the issue.

Appeals

The Department is the final authority. An Appeals Board could be set up, but never has been. There have been no challenges to final decisions.

Mobile Homes

CSA certification is required and municipal zoning regulations apply. The city only inspects foundations.

6.4.7 Vancouver

Scope

Vancouver has its own building by-law, based on the 1980 NBC. Plans are reviewed by the Department of Permits and Licenses, permits are issued and a series of inspections are carried out. Ventilation is verified at the plan-check stage and window dimensions are checked against floor areas. On-site inspections see window sizes verified, duct work checked and fan function tested. The mechanical engineering staff is involved in larger buildings.

Training

Inspectors are all journeymen carpenters with extensive supervisory experience. Some are trained as building technologists at the B.C. Institute of Technology. Inspectors are required to study the building by-law for one hour per week. The B.C. Building Inspectors' Association runs voluntary certification programs.

Appeals

Appeals are handled by the city's Building Board of Appeal, whose rulings are final.

Renovations	Alterations are covered by the permit system but repairs are not. Renovations to historic building have input from the Planning Department.
Mobile Homes	There are no mobile homes in the City of Vancouver and they have never been a factor to be dealt with.

CHAPTER 6 REFERENCES

1. CBOA News and Journal of Building Safety, editor Stirling Ferguson, published four times annually by the Canadian Building Officials Association, free to members, subscriptions $25 per year. Contact Wm. Hewitson, 869 Forest Glen Ave., Burlington, Ontario L7T 2L1

2. OBOA-CBOA Conference, Niagara Falls, Ontario, Oct. 6-9, 1985. A technical seminar on "Construction Technology and Building Codes" was scheduled. For more information, contact Bernie Roth P. Eng., City of Scarborough, Dept. of Buildings, 150 Borough Drive, Scarborough, Ontario M1P 4N7 (416) 296-7660.

3. The Ontario Building Code Newsletter is issued periodically by the branch. It contains articles of interest to building officials, including news items, opinions on code requirements, technical articles, and discussions of court rulings -- interesting reading for inspectors who have had their decisions appealed. Copies are available from the Building Code Branch, 777 Bay St., Toronto, Ontario M5G 2E6. Telephone (416) 585-6666.

4. Ontario Government Bookstore, 880 Bay St., Toronto. Telephone (416) 965-6015 or 1-800-268-7540.

5. For this and other public information, contact Housing Renovation and Energy Conservation Unit, Ministry of Municipal Affairs and Housing, 777 Bay Street, Toronto, Ontario M5G 2E5.

6. An architect in private practice specializing in residential design, a small low-energy design-and-build firm, and a building contractor with experience in tract-houses and custom construction were interviewed.

The building trades can only meet the new NBC requirements if reasonably priced equipment is readily available in the market place. This chapter reviews what mechanical ventilation equipment can now be purchased by building tradesmen from their regular suppliers. Some additional information, based on interviews with Canadian manufacturers, Ottawa equipment wholesalers and on product literature, is provided on the latest products either now available or soon to be released.

Balanced Systems vs. Exhaust-Only Systems

Mechanical ventilation strategies can be classified as either balanced systems or exhaust-only systems. Recent studies by the National Research Council have shown that these two different types of systems can have significant differences in performance.[1]

Either type of system may reclaim some of the heat in the exhausted air, either to preheat the incoming air or preheat the domestic hot water supply. A growing body of literature has examined the performance of mechanical ventilation systems and their impact on ventilation, air quality and energy consumption.[2]

Balanced systems are those which take both supply and exhaust into consideration, with the supply side designed to balance the exhaust side. Balanced systems may consist of both supply and exhaust fans, a heat recovery ventilator for example, or more simply of an exhaust fan with a passive opening calculated to supply the right amount of air, such as permitted by the new requirement in the 1985 NBC. Factory-balanced systems may not remain balanced when actually installed if ductwork in the house is not similar in performance to factory test conditions.

Exhaust-only systems use one or more fans to exhaust stale air from the building and depend on natural infiltration to supply sufficient make-up air. Exhaust-only systems are unbalanced and are inherently undesirable because they tend to depressurize the build-

ing, leading to back-drafting of chimneys and other exhaust systems. Depressurizing the building, however, does have the advantage of minimizing exfiltration and the possibility of moisture condensing in the walls or roof.

Both approaches require a distribution system to effectively ventilate the entire house. Such a distribution system is required to provide mixing of the fresh and stale air throughout the house and to avoid short-circuiting the fresh air supply.

Mechanical exhaust systems, sometimes balanced with a fan-driven fresh air supply, are commonplace in commercial, industrial and agricultural applications, but until recently little equipment has been available for residential applications.

Control Strategies

Unbalanced exhaust-only systems usually feature a simple ON/OFF switch. However, most of the new residential centralized mechanical systems are balanced and feature two-speed fans, set to operate at a low speed to supply continuous ventilation, with manual switching to high speed to eliminate bathroom odors or automatic switching to reduce indoor humidity levels. Automatic controls are typically adjustable humidistats set to trigger on humidity rise.[3]

Other strategies are available: some U.S. systems use only a basic ON/OFF switch, and carbon dioxide variable speed controls, now only practical for complex installations, could be developed in low-cost versions ($200 U.S.) for residential applications.[4] Another U.S. company manufactures a low-cost ($330 U.S. plus shipping) heat exchanger with a 140 cfm exhaust fan and a 100 cfm intake fan. The company claims that running an unbalanced system eliminates balancing problems and solves frost problems down to -25°F.[5]

Two U.S. heat exchanger manufacturers have recently come out with integrated control systems. The Des Champs unit lists for $360 U.S. and includes a humidistat, a timer with three ON/OFF settings, and a three-speed switch for their 200 cfm heat exchanger.[6] (Des Champs also manufactures a 75 cfm single-room venti-

lation system available in both ducted and through-the-wall non-ducted units, for use in less than airtight houses which need supplemental ventilation in some rooms.[7]) Nutone produces a digital controller which includes a humidistat, a variable-speed control, and indoor and outdoor temperature display and an alarm clock. The price has not yet been established. According to a company spokesman, Nutone will be coming out with a second-generation solid-state controller next year that will automatically control indoor humidity as a function of outdoor temperature.[8]

Air Quality Control

While most heat recovery ventilators allow the user to regulate the air-change rate and the relative humidity level, a Canadian company has become the first to develop a control that monitors indoor air quality. Conservation Energy Systems, makers of the vanEE heat exchanger, is now marketing a device called "Air Check." Placed in the living area of the house, this unit continually measures carbon monoxide, carbon dioxide, formaldehyde, ethyl alcohol, cigarette smoke and natural gas in the air. It reacts to many pollutants at once rather than one at a time. When overall air quality drops below preset limits, the unit overrides the manual variable speed control and runs the ventilator at high speed until the pollutant level drops. If propane or natural gas is detected, the monitor shuts down the system and sounds an alarm. Although the $200 unit was designed as an option for the company's heat exchangers, it could be used on other ventilation equipment.[9]

7.1 Available Equipment

Exhaust fans

Conventional residential mechanical ventilation equipment consists of either bathroom or kitchen exhaust fans. Typical bathroom fans available from Canadian HVAC suppliers come with capacities ranging from 50 to 110 cfm, costing from $15 to $75. Vent-type kitchen range hoods come in 160, 200, 360 and 460 cfm models, costing from $36 to $370. Some equipment may be sized in metric units in litres per second, but most is still in Imperial units.

New Products

A variety of more sophisticated residential ventilation equipment is now on the market in Canada, a significant change since 1977 when the Saskatchewan Conservation House had to have its air-to-air heat exchanger hand-made with polyethylene film for the core.

In addition to the rapidly developing domestic industry manufacturing heat recovery ventilators, there is a flowering of other equipment now available from building suppliers, including wind-powered roof-top turbines. Some of these units ventilate the attic only, while others also exhaust air from within the house with pick-up grills in the ceiling and the basement. Attic vent kits typically cost $50-$100 while the whole-house versions range from $200 and up, depending on the amount of ducting and other accessories. Installation costs are extra. These units are usually marketed through building supply stores at the retail level for do-it-yourself installation.

Other new products include a motorized continuous-recirculation system with controlled exhaust and with no heat recovery. This central unit usually mounts in the attic and is connected by flexible ducts to registers in the ceiling and in the basement. When triggered by a humidistat, the recirculating unit begins venting to the outdoors, usually through a soffit. Once the required humidity is attained, the exhaust stops working and an internal shutter automatically closes, thereby preventing infiltration of cold outside air through the ducting.[10]

Some manufacturers recommend that exhaust-only systems be used in summertime as well to reduce basement humidity. One such unit delivers 218 cfm which is claimed to deliver one-half an change per hour for a 1000 square foot house including the basement. Typically, these are unbalanced systems which rely on natural infiltration to supply the make-up air. Wholesale costs are in the $350 range, depending on the ducting accessories included. This type of system is usually sold by plumbing, heating, or electrical wholesalers to contractors, rather than to the general public.

One of the perhaps five or six major HVAC suppliers in Ottawa indicated that over the past year he has sold perhaps two dozen air-to-air heat exchangers and less than one dozen centralized exhaust-only systems. A spokesman indicated that the usual method, over 30 sales last year, is for the company to make up custom systems for roofers and contractors consisting of roof vents and interior ducts and grills. Another popular method is to use a screened, non-dampered 6-inch-diameter through-the-basement wall pick-up connected to the furnace return-air duct. In-duct heaters are sometimes used with this method, 220 volts in the 1.5-4 kW range, complete with in-duct thermostats, wholesaling for about $350.

Other new equipment addresses the problem of balancing interior and exterior pressures. One CSA-approved unit features a barometric damper which automatically responds to indoor negative pressures and allows a compensating supply of outdoor air to enter the house. An element preheats the incoming air if necessary.[11]

One leading Canadian manufacturer of air-to-air heat exchangers has recently started producing an exhaust-only central ventilation system with no supply fan, in the $150 price range. The unit features a 240 cfm centrifugal fan controlled by a humidistat and a bathroom switch. The company estimates that for a typical installation with three exhaust runs of five-inch diameter ducting and one six-inch diameter run to the outside, the exhaust rate will be about 150 cfm. An optional damper, in the $50 range, controls fresh air intake ducts connected to forced air furnaces. When the exhaust system is turned on, the damper opens, allowing fresh air to enter the furnace system.[12]

R-2000 Catalogue

EMR has funded the Canadian Home Builder's Association to produce a catalogue of products suitable for use in R-2000 houses. Entitled A National Catalogue of Residential Energy Conserving Products and Services, it was released in August 1984 and is distributed by CHBA, particularly during workshops to train R-2000 builders.

The catalogue points out that air management systems are a key element in low-energy houses. It points out that controlled ventilation is required for indoor

air quality and to supply combustion air. It lists three product categories: vent and exhaust systems, combustion air supply components, and heat recovery ventilation systems.

It cautions that "exhaust systems should only be used when there are enough openings in the house envelope to allow make-up air into the house."[13] It goes on to list seven products in the exhaust/vent category, all either exhaust vents or furnace outside-air supplies. It contains no listing of any intake vent or make-up air supply products. Two products are listed for supplying combustion air to furnaces and fireplaces and 13 manufacturers of heat recovery ventilators.

The most common mechanical ventilation system, particularly for builders specializing in low-energy construction, remains the air-to-air heat exchanger or heat recovery ventilator, now almost universally installed in low-energy and energy-efficient housing including R2000 houses. These HRV's are the only off-the-shelf products combining a balanced supply and exhaust able to meet the new code requirements.

HRV's cost in the $750 to $1000 range, perhaps slightly more if some of the optional equipment, such as in-line electric defrosters, are included. Installed costs are typically about $1500.

Test Kits

A Saskatchewan company specializing in low-energy housing designs and do-it-yourself air-to-air heat exchangers plans is now branching out into related testing kits. They now offer radon, formaldehyde and air-change test kits. The Fresh Air Change Test Kit sells for just under $200 and is billed as allowing the homeowner to measure both natural and mechanical ventilation rates.[14]

7.2 Equipment Standards

R-2000 Equipment

The Federal Government's R2000 program technical guidelines include a standard for installing mechanical

ventilation systems, slanted toward air-to-air heat exchangers, now usually referred to as heat recovery ventilators or HRV's.[15] These requirements are based on a draft version of CSA Standard C444 for HRV's, prepared by the Heating, Refrigerating and Air Conditioning Institute, the national trade association for the HVAC industry.

A photocopy of the R-2000 document is included in the Appendix. It requires a mechanical ventilation system with a maximum rated capacity of at least 100 cfm (50 L/s) or 0.5 ach, whichever is greater, verified by test measurements after installation. Ventilator equipment and ductwork must be certified to CSA standards. Heat recovery ventilators must be equipped with automatic self-defrosting. Fresh air must be distributed to each room and the system must be balanced within 10 percent. An installation report must be completed.

CSA C444 and CSA C439

CSA Standard C444-M1985 Installation Guidelines for Heat Recovery Ventilators was issued in February 1985 as a preliminary standard to permit development of additional requirements before a formal CSA standard can be issued. As with all preliminary standards, it is expected to be updated within two years. It covers self-contained air-to-air heat exchangers with capacities between 50-400 cfm (25-200 L/s). Units must be certified to the electrical code and to CSA C439, a companion standard entitled Standard Methods of Test for Rating Performance of Heat Recovery Ventilators issued in May 1985. CSA C439-M1985 is also a preliminary standard, due to be updated within two years. A draft version of the standard has been used by the Ontario Research Foundation to test HRV equipment.

CSA C444 requires a capacity of 10 cfm (5 L/s) per room, supplied continuously or 0.5 ach for the building. The units are required to defrost automatically and intake and exhaust must be balanced within 10 percent, including during defrost. An installation report form with copies to the purchaser, regulatory authority, manufacturer and installing contractor is required. The draft version of the standard required testing after installation to measure and verify the flow rates.

These two standards were not released until after the 1985 NBC had been finalized, but it is unlikely that they would have been referenced, as energy conservation and heat recovery are not considered as falling within the NBC's domain. Codes are permitted, however, to reference only portions of standards, so it is possible that just the tests for airflow, for example, could be referenced from the HRV standard.

No comparable standards exist for self-contained, balanced mechanical equipment without heat recovery and no such products are yet available.

Other CSA Standards

CSA Standard C260.1-1975 Installation Code for Residential Mechanical Exhaust Systems provides instructions on where to locate exhaust fans for best results, how to select fans with adequate air movement capability and how to select the right sizes of ducting, dampers and terminal fittings to keep resistance to flow within the fan capacity. The companion standard, C260.2-1976 Residential Air Exhaust Equipment, establishes a uniform method of testing to determine capacity and noise of installed equipment.

The initial impetus for creating these two standards apparently came from the electric utilities as the result of the need for ventilation requirements in all-electric houses. Although they would appear to be an obvious choice for confirming compliance with basic mechanical exhaust requirements, neither of these standards is referenced in the National Building Code.

Although both standards are still valid, they have not been updated in the ten years since their publication and there is some concern that they may be out of date. CSA reports that there are no products certified to C260.2.

CSA Task Force on Controlled Ventilation

With funding from Energy, Mines and Resources, CSA has established a Task Force charged with developing a draft standard on controlled ventilation for its Committee on Energy Conservation in Housing.[16] The Task Force hopes to have its recommendations and a

draft standard, possibly based on the ASHRAE 62-81 requirement of 5 L/s per room, worked out by early 1986 when they will be presented to a yet-to-be-established Committee on a Standard for Controlled Ventilation. It is not yet clear when such a CSA Standard might be available. Among other jobs, the Task Force will be examining the relevance of existing standards, including CSA 260.1 and 260.2

U.S. HRV's

In the U.S., the Home Ventilating Institute Division of the Air Movement and Control Association has met with manufacturers to serve the residential air-to-air heat exchanger industry. The HVI currently provides testing and certification for residential equipment such as kitchen and bathroom exhaust fans. There are currently no testing or performance standards for HRV's in the U.S. and they depend almost completely on Canadian standards and testing. Several Canadian requirements are considered unnecessary for most U.S. climates, particularly the freezing tests.[17] In spite of that, within the U.S. the general consensus is that the best air-to-air heat exchangers still come from Canada.

According to one report in the U.S. low-energy building press, several high-volume builders are looking at air-to-air heat exchangers and are lobbying major HVAC manufacturers to reduce the high cost of such devices by including them as part of their air handlers.[18]

7.3 Residential Construction Industry

Canadian Home Builders Association

In 1983 the Canadian Home Builders' Association, then known as the Housing and Urban Development Association of Canada (HUDAC), produced a summary of guidelines for CMHC, providing advice to builders on how to ensure adequate ventilation in tight houses. Entitled Guidelines for the Design and Installation of Residential Controlled Ventilation Systems: a Summary, the report consists of information on ventilation requirements, recommended systems, testing, operation and mainten-

ance. It applies to all housing, not just those funded under the R-2000 program, and to all mechanical systems, not just those with heat recovery. The basic requirements are based on ASHRAE 62-81.

According to CMHC, work is continuing on the project. In an eight-house demonstration project the guidelines were found to be unsuitable both technically and because they were addressed to builders. The guidelines have been re-evaluated and recommendations are being made to change them to reach HVAC contractors, the group targeted as the key to their success.[19]

In the meantime, however, the 1984 R2000 Guidelines for the Installation of Residential Controlled Ventilation Equipment have been established and the Canadian Home Builders Association now unofficially considers this standard as applying to all housing construction, not just to the R-2000 program exclusively.[20] The CHBA is doing no further work in this area.

Heating, Refrigeration and Air-Conditioning Institute (HRAI)

Because of the many problems associated with improperly installed systems, the R-2000 program now requires that HRV's be installed by certified installers, a requirement of the new CSA C444 standard. The Heating, Refrigeration and Air-Conditioning Institute in Toronto has started a certification program, with a cross-Canada series of one-day seminars during the spring of 1985. Those attending received hands-on work on a demonstration unit and an Installer's Manual. Response was excellent with over 1000 attending the series, and plans are underway to repeat the course for a similar size audience in the spring of 1986.[21]

HRAI is working on a Design Manual for Residential Ventilation, due for release in early 1986.[22] It is expected to take either an assumed air change rate (perhaps 0.3-0.5 ach) or a specified volume (perhaps 5 L/s per room, similar to ASHRAE 62-81) and show how to design a mechanical system to deliver that amount to all rooms of the house.

HRAI hopes that this Design Manual will be referenced in provincial building codes which, it believes, will solve the problem of enforcing the new 0.5 ach require-

ment of the 1985 NBC. HRAI is concerned that the new NBC requirement applies to all houses regardless of their degree of airtightness.

Ontario New Home Warranty Program

The New Home Warranty Program, established as a non-profit corporation by the Ontario government in 1977, ensures that buyers of new homes are protected against financial loss up to $20,000 because of defects in workmanship or materials or major structural defects or if the builder goes bankrupt. All builders and vendors of new homes in the province are required to be registered with the program. The registration fee is $350, with an enrollment fee for all houses of $50 plus $2 for each $1000 of the sale price.[23]

A brief controversy flared during the winter of 1984-85 concerning warranty coverage of low-energy houses. The controversy began when the Warranty Board issued a Bulletin in November 1984, requiring builders of energy-efficient houses to post a $20,000 bond for seven years for each unit built because, it argued, these houses are still in the development stage and therefore represent a higher risk. According to the next special Bulletin, a "mutually satisfactory agreement" was reached to exclude houses built under the federal government's R-2000 program from the requirement. In January 1985, the New Home Warranty Program issued Bulletin No. 13 in an attempt to resolve the issue. A photocopy of that bulletin is included in the Appendix.

Bulletin 13 withdrew the bond requirement for all houses with airtight construction provided several procedures were followed, including the installation of a ventilation exhaust fan with a 1 ach capacity.

Designers, Builders

A spot-check with an architect, a developer and a builder in Ontario indicates that ventilation equipment may be specified by the designer, a contracts manager or the contractor. Typically they specify their usual make and model, often unaware of the unit's capacity. In tract housing, drawings are often simply labelled "exhaust fan" with the selection left up to the contractor or even the electrician who usually base their

decision on cost or appearance rather than capacity.

As a group, they felt that inspectors only checked on whether a fan was installed or not, without bothering to check either capacity or air change rate. The feeling of the group was that ventilation is not an issue at the municipal level, but they all agreed that CMHC and provincial housing authority projects get much more rigorous inspections.

A similar spot-check with several builders and designers specializing in low-energy construction indicated that they invariably specify and install HRV's. One of these builders indicated that even when he builds houses where the customer does not want an HRV he installs the necessary ductwork anyway, so that if he is called back in the future to solve humidity problems the installation of the equipment will be easier and cheaper.

HRV Industry Reaction

A spokesman for an HRV company interviewed during this study pointed out that the best way to meet the new code requirements for one-half an air change and make-up air is to install a HRV according to the CSA installation code. Anything else, he said, would be inadequate in meeting the intent of the law. The new requirements, he felt, were insufficient because they fail to reference any product or performance standard. Thus, there is no required method of testing for compliance. He suspected that the housing industry did not want such a test as it would become yet another expensive requirement for the inspector to check on.

He admitted that the new code is a step in the right direction, but explained that allowing an existing exhaust fan plus a hole in the basement is little improvement over the former requirement as any energy-conscious home-owner will simply plug the hole. He could not understand why the code had not specified a balanced supply-and-exhaust system to avoid this problem. Now, he said, it is just left up to individual builders and inspectors to work out between themselves what meets the requirements.

He said that his company could supply equipment to meet the new requirement if only there was information on how to meet it and how to check for compliance. Because he doesn't know what equipment will be considered as meeting the requirement he won't risk the start-up costs for a new product line.

CHAPTER 7 REFERENCES

1. C.Y. Shaw, The Effect of Mechanical Ventilation on the Air Leakage Characteristic of a Two-Storey Detached House, Building Research Note No. 204, Division of Building Research, NRC, July 1983, 17 pages plus illustrations.

2. See Indoor Air Quality in Tight Houses: a literature review, by David Coon for the Housing Conservation Unit of the Ontario Ministry of Energy, December 1984, 120 pages.

3. For a review of performance requirements and control strategies, see "Feature: Ventilation System Control Strategies" in Energy Design Update, February 1985, page 5.

4. See "Carbon Dioxide Controlled Ventilation Systems for Houses." Energy Design Update, February 1985, page 4. It cites a Commission of the European Communities study which concluded that "since a CO_2 controlled system would reduce unnecessary ventilation, it could provide a twice-better payback than an air-to-air heat exchanger." For information on an ON/OFF only system, see "Heat Recovery Ventilators in Five Different Capacities" in the same issue on page 17.

5. See "Heat Exchanger Breakthroughs" in Progressive Builder, published as an insert in Solar Age magazine, July 1985, page PB6.

6. See "Integrated Ventilation System Controls" in Energy Design Update, March 1985, page 13.

7. For more information, contact Des Champs Labs, P.O. Box 440, East Hanover, New Jersey 07936.

8. For more information, contact Robert Hoffman, Nutone Housing Group, Scovill Inc., Madison and Red Bank Roads, Cincinnati, Ohio 45227; (513) 527-5112.

9. For more information, contact Rick Olmstead, Conservation Energy Systems, Box 8280, Saskatoon, Saskatchewan S7K 6C6; (306) 665-6030.

10. Systems like these are manufactured by Venmar Ventilation Inc. and by Aston Industries Inc., Residential Division, P.o. Box 220, St-Léonard d'Aston, Québec J0C 1M0;

tel (819) 399-2175. The cover of the brochure for the Aston Atic 2000 features a quotation from NRC's Housing Note 11: "Excessive condensation of moisture on windows is a source of increasing concern in Canadian homes...."

11. Product literature, Venmar Inc. Ventilation, no address or telephone given.

12. For more information on the EX 200 Central Exhaust System and the optional Air Control Damper, contact Conservation Energy Systems, Box 8280, Saskatoon S7K 6C6, telephone (306) 665-6030.

13. A National Catalogue of Residential Energy Conserving Products and Services, prepared by Renewable Energy in Canada for Canadian Home Builders' Association, August 10, 1984, page 145. The publication is slated for annual updating; during the summer of 1985 work was underway on the next edition.

14. Product literature, Northern Scientific Inc., Box 917, Regina, Saskatchewan S4P 3B1. Telephone (306) 757-4666.

15. For a discussion of industry reaction to this draft standard, see Review of Technical Requirements for R-2000 Houses (Interim Report), prepared for Energy, Mines and Resources by the Bureau of Management Consulting, Ottawa, January 1985, 40 pages, cirlox bound.

16. Interview with Brian Rossborough, Senior Standards Administrator, Canadian Standards Association, Rexdale, Ontario. Members of the Task Force are CMHC's Peter Russell, NRC's Ken Latta, EMR's Skip Hayden, and HRAI's Doug Geddes. A consultant will be hired to assist the group.

17. "HVI Discusses Testing and Certification of Residential Air-to-Air Heat Exchangers," Energy Design Update, Vol. IV, No 4, April 1985, page 1.

18. "Volume Builders Taking Residential Ventilation Seriously," Energy Design Update, March 1985, page 2.

19. Interview with Peter Russell, Research Division, Canada Mortgage and Housing Corporation, Ottawa.

20. Interview with Robert Munro, Canadian Home Builders Association, June 1985.

21. Information on future HRV installer certification courses can be obtained from local HRAI chapters, EMR's provincial CREO offices or local CHBA/R-2000 officials. For more information on the course itself, contact The Heating, Refrigerating and Air Conditioning Institute, 5468 Dundas St. W., Suite 226, Islington, Ontario M9B 6E3.

22. Interview with Doug Geddes, HRAI.

23. For more information, contact the New Home Warranty Program, 600 Eglington Ave. E., Toronto, Ontario M4P 1P3 (416) 488-6000.

8.1 Canada Mortgage and Housing Corporation

Background

Established in the late 1940's, the Canada Mortgage and Housing Corporation (CMHC) was empowered under the National Housing Act to prepare standards on housing and apartment construction for mortgage purposes.

Residential Standards

In the late 1950's, CMHC's standards-writing responsibility was transferred to the National Research Council's Associate Committee on the NBC. In 1958 the first NRC-produced Housing and Apartment Standards was produced. In 1960 the health and safety related requirements were incorporated as Part 9 of the NBC. In 1965, the Canadian Code for Residential Construction was released, combining the mortgage-related requirements of CMHC with the health and safety requirements of Part 9 of the NBC. In later versions, this publication was renamed Residential Standards.

The current edition of CMHC's Residential Standards is 1980, based on the 1980 NBC and the same ventilation requirements apply.[1]

The Standing Committee on Housing and Small Buildings, responsible to the Associate Committee on the National Building Code, prepares Residential Standards as the minimum requirements for housing constructed under the National Housing Act. CMHC administers the act and uses Residential Standards to help achieve its objective of improved housing and to protect its financial interest. Residential Standards is often used as an unofficial guide to residential construction by designers, builders and inspectors as well as by private mortgage insurers, provincial housing corporations and educational institutions.

Residential Standards contains the requirements of Part 9 of the NBC with regard to matters affecting

health and safety and identical wording is used in both documents in most instances. The NBC requirements appear in bold-face type. In addition, Residential Standards contains other requirements for mortgage lending purposes which go beyond traditional building codes to include such matters as landscaping, painting, closets and kitchen counters. These additional requirements constitute about 10 percent of the document, and appear in light-face type to distinguish them from the NBC requirements.

Requirements

CMHC requires either natural ventilation with the standard minimum opening sizes by room type, or mechanical ventilation with a capability of at least one air change per hour for that room.

Status

Although Residential Standards duplicates all the requirements of Part 9 of the NBC, it is still incomplete as users must refer to other parts of the NBC for requirements such as non-combustible construction and mixed occupancy. The NBC Associate Committee has recently recommended to CMHC that the format of Residential Standards be revised to include only the non-code requirements and be issued as a companion document to the NBC.[2]

No decision on the new status of Residential Standards has yet been made by CMHC senior management, although a resolution is expected soon.[3]

Currently, the 1980 edition of Residential Standards is enforced for NHA construction. If and when a new set of standards is adopted by CMHC, the agency will use its Builders' Bulletin newsletters to inform its regional offices and inspectors of any new requirements. At that time, builders will have a six-month grace period during which they can build to either the new or old requirements.

Participants under the National Housing Act are required to conform to Residential Standards as well as to provincial and municipal requirements. In the case of differing requirements, CMHC requires that the more restrictive regulations apply. Thus in the case

of NHA housing in jurisdictions where the 1985 NBC is already in effect, those regulations would supercede Residential Standards and obviously they would have to be met to obtain a local building permit.

Inspector Training

CMHC operates 58 offices throughout the country, with about 260 inspectors in two categories, compliance level and fully qualified.[4] All inspectors undergo national exams set up by the corporation, while fully qualified inspectors take special exams to handle more complicated, multi-unit buildings. Special training courses are held for particular inspection procedures.

There are two types of inspectors, those with seniority who are generally qualified tradesmen with site-superintendent experience and newer inspectors who are usually engineers or certified architectural or engineering technologists.

CMHC inspectors do about 280,000 inspections a year for CMHC mortgage insurance programs, federal social housing programs and other federal government departments where they are contracted-out to perform inspections. For example, CMHC inspectors work for Consumer and Corporate Affairs doing UFFI removal inspections, for Indian and Northern Affairs inspecting housing on reserves, for EMR on the Canadian Home Insulation Program (CHIP), and for provincial Housing Warranty Programs in the Atlantic region, Manitoba, Saskatchewan and B.C.

Enforcement

CMHC is involved in both new construction and renovation. Construction plans are reviewed and inspections are carried out. Ventilation, both natural and mechanical, is checked at the plan-review stage and in the field. Fans are rated, calculations are done to relate fan capacities to room sizes and mechanical system function is checked during the final inspection. The corporation has the ability to enforce standards through holdbacks of funding or insurance.

CMHC inspectors have a good, but informal working relationship with local authorities. Inspectors from

both jurisdictions belong to the same provincial building official associations.

CMHC has prepared a 17-minute audio-visual presentation to help explain the new provisions of the 1985 NBC to senior inspectors, who will take it back to the regional offices and use it to introduce the new code to all levels of inspectors. It is expected that CMHC's marketing staff will organize public distribution of the presentation once it has been circulated internally.[5]

Modular and Mobile Homes

CMHC involvement with modular and mobile homes is the same as in new construction or rehabilitation -- any consumer-purchased housing that involves CMHC loans or mortgage insurance necessarily involves the corporations's inspectors. Modular homes are a concern to CMHC. The corporation randomly inspects for conformance to Residential Standards at the factory. CMHC has encountered ventilation problems with mobile homes built to the CSA Z240 standards and has tried, unsuccessfully, to have Residential Standards included in CSA Z240.

RRAP Standards

Standards for the Rehabilitation of Residential Buildings are used for work funded by CMHC under the Residential Rehabilitation Assistance Program (RRAP).[6] The ventilation requirement calls up Residential Standards. The Appendix explains that air sealing and insulating result in lower air change rates, causing unacceptable levels of water vapour and contaminants. It says that ventilation must be provided to ensure adequate fresh air to exhaust these pollutants safely to the outdoors.

CMHC Recommendations

CMHC's Research Division produces a series of information transfer documents, for distribution by local offices, that are widely used by inspectors, builders and home-owners.

Energy-Efficient Housing Construction, well-regarded within the low-energy building community, explains that this type of house requires additional ventilation to ensure that indoor air is replaced at a minimum rate

of one complete change every two to three hours.[7]

Controlled ventilation, it suggests, can also provide for heat recovery. Bathroom and kitchen exhaust fans should be routed downward and out through the floor header rather than through roof vents to reduce convection heat losses although longer runs may require a larger duct to reduce flow resistance.

Another CMHC book, Condensation in the Home, does not deal with mechanical ventilation except to say that exhaust ducts should always go to the outside of the building (never into an attic or other unused space) by the shortest route.[8] For electrically heated houses it recommends the controlled intake of outside air by means of an insulated duct from outdoors connected to the cold air plenum of the forced-air furnace. For baseboard electric heated houses it suggests a manually controlled mechanical ventilation system to provide fresh air. It cites two other methods successfully used to vent electrically heated houses: a non-dampered vertical vent extending from a second-storey bathroom directly to the exterior through the roof or, for single-storey houses, a vent or "dummy chimney" extending vertically from the basement through the roof.

While the dummy chimney approach will undoubtedly provide extra ventilation, its lack of control results in unnecessary heat loss, thereby defeating the purpose of a tight house.

CMHC has investigated moisture problems leading to rotting of wood in walls and ceilings in electrically heated houses in the Maritimes, an area with high outdoor humidity levels. CMHC and the Newfoundland and Labrador Housing Corporation have jointly produced a booklet for public distribution called Moisture and Air: Problems and Remedies. It recommends passive ventilation through the attic or mechanical exhaust through the wall, controlled intake of outside air to the return duct of a forced air furnace, simple passive inlets installed where they won't cause drafts, and dehumidistat control on a ventilating system activating a high-speed fan with the low speed running continuously. It further states:

A continuous mechanical ventilation, at 35 L/s (70 cfm) should be used in all well-built houses.[9]

8.2 R-2000 Program

The R-2000 program, also known as the Super Energy Efficient Home (SEEH) program, is sponsored by Energy, Mines and Resources and delivered through the Canadian Home Builders' Association. The program's objective is to assist the Canadian housing industry to develop the capability to construct and market housing that is both energy efficient and cost effective.

During the demonstration phase, 300 R-2000 houses were built and training seminars were given to some 1500 builders across the country. The R-2000 Home Program mandate has now been extended to 1991 with the goal of promoting the construction of 20,000 additional R-2000 houses. Many builders go on to build "repeater" houses -- units with the same R-2000 standards but not built as part of the demonstration program.

Requirements

As of August 1, 1984, the ventilation requirement for an R-2000 home called for the demonstrated capability to supply 0.5 air changes per hour or a minimum of 50 L/s (100 cfm), whichever is greater, of continuous variable-speed controlled mechanical ventilation for the whole building. A distribution system must provide continuous ventilation air to each room.

Mechanical ventilation equipment, including air-to-air heat exchangers or similar heat recovery ventilators, must be installed in accordance with Guidelines for the Design and Installation of Ventilation Equipment.[10] An installation report must be completed and submitted to CHBA.

Status

During 1984 a review of the technical requirements for R-2000 homes, based on interviews with over 70 builders, researchers and others knowledgeable in the field, was conducted by the Bureau of Management Consulting. According to an interim report, dated January 1985,

> **there was general agreement on the requirement for a minimum ventilation capacity of 0.5 ach but many interviewees recommended an additional requirement for a continuous minimum ventilation rate somewhat lower, perhaps 0.3 ach.**[11]

The interim report recommended that ventilation requirements be specified in terms of the rate in L/s based on ASHRAE 62-81 to provide continuous ventilation capable of being increased under manual or automatic control to handle moisture and other contaminants up to the existing maximum rate.

Status

The 1984 technical requirements are in the process of being revised, likely in line with the review's suggestions, but no confirmation was available in time for this report.

8.3 Northern Housing

Another model document, this one an energy-oriented residential standard suited for the North, including the Northwest Territories, the Yukon and provincial areas with permafrost, went through six drafts and was available for public review during 1984.[12] Northern Residential Standard for Energy Efficient Housing was printed in March 1985 under a new title Measures for Energy-Efficient Northern Housing, first edition, 1985, more simply referred to as Northern Measures. A photocopy of the ventilation requirements is provided in the Appendix.

Background

Northern Measures was prepared by an interdepartmental committee charged by the Federal Government with producing the standard in time for the 1984 construction season. A revised timetable now predicts its use for the 1986 season.

Energy, Mines and Resources formed a committee in 1982 to write the document with members from territorial and provincial governments, from other Federal departments involved in the North and from the private sector -- designers and builders with experience in northern construction. The Secretary for the committee is an EMR CREO official in Yellowknife.

The goal of the project has been expanded from an energy conservation standard applying to Federally controlled housing in the North to a broader document giving direction on a wide variety of construction problems unique to housing in the North, with the hope that it will be adopted by a variety of other agencies and governments.

Sources

Northern Measures is heavily based on CMHC's 1980 Residential Standards, updated with the new requirements of the 1985 NBC and expanded by the expertise of the technical committee. A photocopy of the ventilation requirements is included in the Appendix. Clauses that have been altered from Residential Standards are marked with a vertical line in the margin and those taken from the 1985 NBC are so labelled. Because the 1985 NBC requirements have already been discussed, this section deals with only those requirements that go beyond the two parent documents.

Requirements

As would be expected, the thermal insulation requirements reach superinsulation levels -- walls and roofs ranging from RSI 5.61 in 6500 degree-day Celsius zones up to RSI 7.78 in 12,500 degree-days zones [Article 26.B.2]. Air-vapour barriers are to be sealed [Article 26.C.6], with films at least 0.15 mm thick [Article 26.E.6]. The building must have an equivalent leakage area of less than 170 mm^2 per 1 m^2 of building envelope area if pressure-tested [Article 26.E.1].

Section 33 provides the details on Ventilation and Heat Recovery. Either natural or mechanical ventilation is called for, but a rider has been added:

the ventilation must be adequate to maintain air quality at acceptable levels for occupants. This requirement means that for the first time, a Canadian standard is now associating ventilation with indoor air quality.

General requirements specify that combustion equipment discharging to the outdoors through a flue must be supplied with combustion air and be isolated from the dwelling space [Article 33.B.2]. If mechanical equipment does not supply a full air change per hour, natural ventilation must be provided [Article 33.B.3]. Air contaminants, including fumes from gas refrigerators or portable kerosene heaters, must be removed at source with a range hood or exhaust fan [Article 33.B.4].

Northern Measures, First Edition, 1983

B. GENERAL	
(1)	**Ventilation adequate to maintain air quality at acceptable levels for occupants shall be provided to rooms or spaces within dwellings, either by means of a natural ventilation system, in conformance with Subsections C and E, or by a mechanical ventilation system in conformance with Subsections D and E.**

Natural ventilation

For natural ventilation, the same minimum unobstructed areas are specified as in Residential Standards and the NBC. Work rooms and service rooms have been added and have to meet the same size openings as bathrooms, 0.09 m^2 (1 square foot). Where windows or ducts are not used, the vent closures must provide a minimum RSI 2.0 with seals on the warm side and hardware for holding the vents open and fastening them closed [Article 33.C.2]. Where operable windows or vents are used, they must not allow frost or ice to prevent their operation [Article 33.C.3].

Mechanical ventilation

If mechanical ventilation is used it must be capable of running continuously and providing at least 1.0

ach. It must be provided with a variable speed control and an ON/OFF switch.

Outdoor inlet and exhaust openings must be located where wind pressures will be less than 20 percent of the static pressure of the operating fans [Article 33.D.2]. Outside air must be tempered to at least 15°C before it enters a habitable room [Article 33.D.3].

A variety of additional specifications cover the design and installation of intake and exhaust ductwork and grills, including the use of a mixing device on outdoor ducts connecting to forced-air furnaces [Article 33.E.1-11].

Northern Measures, First Edition, 1985

D. MECHANICAL VENTILATION SYSTEMS

(1) **Where a mechanical ventilation system is provided, it shall be designed to be capable of operating continuously and of providing a maximum rate of air change of at least 1.0 ach. based upon the finished interior volume of the dwelling unit. The system shall be provided with a variable speed control and a switch to allow the system to be turned off.**

Heat Recovery

An entire subsection has been included on heat recovery systems [Article 33.G]. If such equipment is installed, it must be balanced, air streams must be filtered, and the core must be cleanable. Any frost blockage must be thawed as quickly as possible and ventilation must continue even if the heat recovery aspects are not operating. Condensed water must be drained off.

Combustion air

Section 34 Heating and Air-Conditioning requires that all combustion equipment must be supplied with combustion and dilution air from outdoors to prevent interaction with the room air, with the air tempered to at least 10°C. Furnace rooms, if used, must have their own outdoor air supply, and combustion appliances in all other locations must prevent their combustion gases being drawn into the house by other equipment by such

design features as air intakes, flues, enclosures or access doors.

Rationale

A companion document provides a commentary on the proposed Northern Measures.[13] The Commentary points out that the ventilation and heating sections deal with the most difficult and controversial aspects of the standard.

The Commentary points out that windows are frequently an unsatisfactory means of providing ventilation. Their use leads to cold drafts and they often cannot be closed again because of ice on the jambs. Specially designed ventilation openings are recommended until window design improves.

While the mechanical ventilation system must be designed to provide 1.0 ach and to operate continuously, it is not intended that this rate be maintained at all times. The system must be controllable to suit the needs of the occupants and be capable of being switched off when the building is unoccupied.

The wind pressure requirement on intakes and exhausts means that in most cases they cannot be located in exterior walls. Elevated buildings can draw their air from crawl spaces, provided the pick-up is near the centre to avoid venturi or eddy effects near the edge. Warm air should not be exhausted into crawl spaces on permafrost. Exhausts and also intakes should be taken through the roof in an area reasonably free of wind turbulence.

Preparation of a Handbook of Northern Canadian Residential Building Practice has begun as a joint effort of the National Research Council, Canada Mortgage and Housing Corporation, and Indian and Northern Affairs Canada. The handbook will encompass both the principles of good design and the construction details that have been used.

Status

Plans for the future of Northern Measures are not certain. According to EMR officials, Treasury Board

has specified that all housing in the North constructed with federal assistance, estimated at 80 per cent of the total, must use the document but no funds have been assigned for implementing it. Current plans call for using the standards for a trial period of a year and then modifying them based on that experience. A memorandum will then be sent to Cabinet with suggestions for implementation, perhaps in the form of a demonstration project.

Unofficially, Federal departments may already be using Northern Measures.

8.4 Canadian General Standards Board

Retrofit Air Sealing

The Canadian General Standards Board has a Committee on Air Sealing charged with working on standards for this developing technology. Two working groups have been established, one dealing with prescriptive requirements for retrofit air sealing and the other devoted to ventilation requirements after air sealing.

The Working Group on Ventilation Requirements after Retrofit Air Sealing was established in November 1984, with 14 representatives from air sealing companies and the scientific community, plus federal agencies concerned with indoor air quality (Health and Welfare, Consumer and Corporate Affairs, CMHC, NRC and EMR). The committee has already developed a draft standard based on the ASHRAE 62-81 ventilation requirements but with a novel approach.[14]

Draft Standard

The draft CGSB standard is intended to determine compliance with the ASHRAE rates and is to be applied to existing residences whose uncontrolled air leakage has been reduced by retrofit air sealing.

The most important feature of this proposed standard is that it recognizes that ventilation does not have to be continuous to be adequate. The standard is based on an average ventilation rate over one day rather than requiring continuous ventilation. If a specified calculation, which uses a measured Equivalent Leakage Area, shows that natural forces can supply the ASHRAE requirements averaged over the day, then natural ventilation will be adequate to meet the standard. Auxiliary ventilation is only required to make up the shortfall.

Requirements

The ventilation requirement is calculated by summing the ASHRAE requirements of 5 L/s per room. The intermittent capacity of 50 L/s for kitchens and 25 L/s for bathrooms may be met by manually controlled exhaust fans. Steady-state for kitchens is 5 L/s, for bathrooms zero. The draft standard provides the means to ascertain that this calculated requirement is being met by requiring a fan depressurization test to determine air tightness.

Enforcement

After the house has been air-sealed, its level of airtightness is tested according to CGSB Standard CAN2-149.10-M85 "Determination of the Airtightness of a Building Envelope by the Fan Depressurization Method,"- with one modification. The intentional openings in the building envelope are to be left in their normal position.

A special procedure uses the Equivalent Leakage Area (ELA) plus other house characteristics (height, volume and geographic location) to calculate how much ventilation the house will have under natural forces. If the calculations show that natural ventilation supplies the required amount of fresh air, no mechanical ventilation is required. Mechanical ventilation is only required when needed to supplement insufficient natural ventilation.

Auxiliary ventilation is to be controlled by a manual ON/OFF switch and/or by an automatic controller which supplements natural ventilation as required. This device could either measure humidity, levels of sig-

nificant pollutants, or outdoor temperature and wind velocity.

Commentary

This approach is inherently energy efficient as mechanical ventilation need only be used when natural ventilation is insufficient, typically during the spring and fall "shoulder" seasons when the driving forces for infiltration -- wind and the difference between indoor and outdoor temperatures -- are low. The key to this concept is that the capacitance of the house volume to moderate rises in contaminant levels under low ventilation rates is accounted for by allowing an average ventilation rate rather than requiring continuous ventilation.

While the current version will apply only to existing housing with retrofit air sealing, it could be applied more broadly to any house undergoing any type of energy conservation retrofit or even to new housing.

Status

This a draft standard only and work is continuing. Several issues are still unresolved, relating to combustion air supply and to health issues. The Ventilation Working Group is expected to report back to the full committee late in 1985.

8.5 Mobile Homes

Jurisdiction

As pointed out under the provincial and municipal review in Chapter 5, jurisdiction over mobile homes varies across Canada.

The National Building Code is intended quite clearly

to apply to mobile homes. According to Subsection 2.1.4 in both the 1980 and 1985 editions:

> **This Code applies to both site assembled and factory made buildings.**

The word "building" in the NBC is defined as meaning "any structure used or intended for supporting or sheltering any use or occupancy."

Ontario

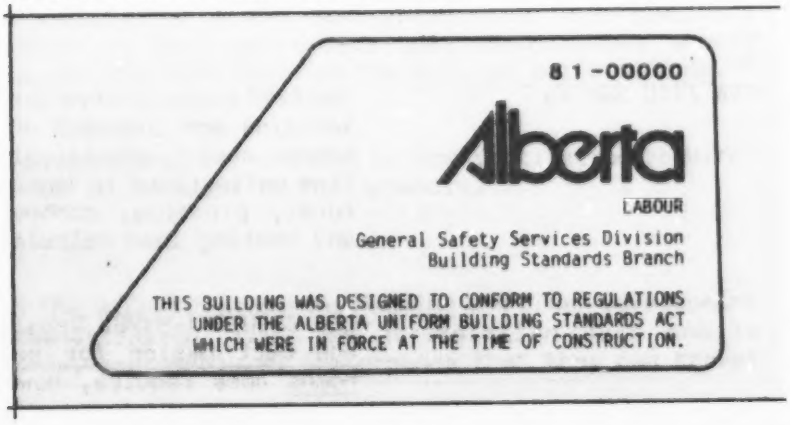
The Ontario Building Code has clarified the phrase "factory made buildings." The provincial code covers site-assembled and "manufactured buildings." Manufactured residential buildings that are constructed in sections not wider than 4.3 m and that comply with CSA Z-240 standards for mobile homes are exempt from the code.

Thus, factory prefabricated modular houses are required to meet the building code while mobile homes are required to conform to CSA Z-240 standards.

Alberta

Alberta requires labels affixed to mobile homes and manufactured homes which confirms that the unit meets the requirements of the current Alberta Building Code for a single-family house, which means that the unit will be accepted as such by municipal officials, purchasers and lending agencies.

Alberta Mobile Home Certification


81-00000
Alberta
LABOUR
General Safety Services Division
Building Standards Branch
THIS BUILDING WAS DESIGNED TO CONFORM TO REGULATIONS
UNDER THE ALBERTA UNIFORM BUILDING STANDARDS ACT
WHICH WERE IN FORCE AT THE TIME OF CONSTRUCTION.

The labelling program is a cooperative effort by the provincial Building Standards Branch and the Canadian Standards Association. CSA reviews the plans and both CSA and provincial inspectors periodically inspect the manufacturing plant to monitor production. CSA supplies certification labels to confirm compliance.

Mobile Home Standards

CSA Standard A277-M1981 Procedure for Certification of Factory-Built Houses provides for the certification for plant quality control as well as the products. This standard specifies that manufactured homes must conform to the National Building Code and to Residential Standards while mobile homes are required to conform to the CSA Z240 series of standards. Homes designed to be installed on a permanent foundation are considered manufactured homes.

Mobile homes are defined as transportable single or multiple section single-family dwellings ready for occupancy after completion of factory-recommended set-up procedures. They must be complete structurally with the entire plumbing, electrical and heating services installed.

Product certification is based on periodic and random in-plant inspections by CSA officials. According to a Standards Administrator with CSA, although certification is voluntary, virtually all mobile homes in Canada are certified to CSA Z240, the only exceptions being custom-made units intended for work camps in remote locations.[15]

CSA Z240 Series

The Z240 series covers both mobile homes and recreational vehicles and consists of 15 separate standards. Only seven apply specifically to mobile homes, ranging from definitions to requirements for vehicular, structural, plumbing, combustion equipment installation, and heating load calculations.

CSA Z240.9.1-M1982 Requirements for Load Calculations and Duct Design for Heating and Cooling of Mobile Homes does require, however, that "where ventilation

or make-up air in addition to infiltration is specified, it shall be taken directly from outside of the mobile home and compensation shall be provided in the heat-loss calculation in accordance with the HRA Digest (0.38 m^3/min per person with two persons assumed per bedroom)." [Article 4.5] Note that this requirement only applies "where ventilation ... is specified."

A spokesman for the Heating, Refrigeration and Air-Conditioning Institute (HRAI) acknowledged that the reference to "the HRA Digest" was to one of their publications but he was unfamiliar with the specific numbers or their source.

Until 1984, none of the mobile home standards contained any specific ventilation requirement. Since that date, however, new mobile homes are required to have the same 0.5 ach capability as required in the 1985 NBC.

Revisions to Z240.2.2 entitled Structural Requirements for Mobile Homes, issued in April 1984, require each new mobile home to have a mechanical ventilation system capable of providing 0.5 ach, based on the interior volume. Inlets and outlets must be sized to supply that capacity. The system must be capable of continuous ventilation, either automatically or manually controlled. If kitchen or bathroom fans provide a portion of the required air change, they must be controlled by a humidistat. Instructions on using the ventilation system to reduce indoor humidity are to be included in the owner's manual.

According to a CSA spokesman, the organization's intent is that the mobile home requirements should not deviate from those in the National Building Code.[16]

A photocopy of the new mobile home ventilation requirements is included in the Appendix.

Mobile Homes in the U.S.

In the United States, the Housing and Urban Development Administration (HUD) has jurisdiction over mobile homes, presumably on the grounds that they can travel

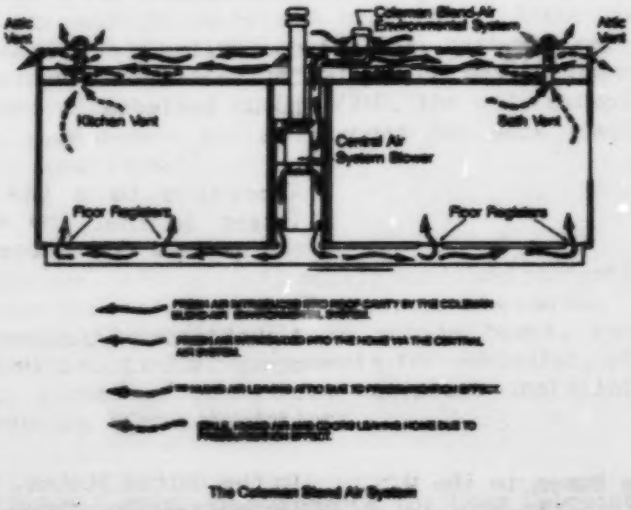
between states, whereas houses come under state jurisdiction.

According to a recent U.S. newsletter, HUD has recently passed stringent requirements concerning indoor air quality in mobile homes. The article claims the U.S. federal government may promote similar regulations for other housing types with two years.

Beginning in February 1985, all manufactured home dealers must offer "mechanical ventilation improvement devices," with a required 25 cfm outdoor air supply, as an option on all mobile homes they sell and salesmen must inform potential buyers of the available options.[17]

When the regulation was issued, the Coleman Company modified a unit then under development for pressurizing attics to reduce moisture condensation. The company has now introduced its "Blen Air Environmental System" to meet the HUD requirements by supplying fresh air to pressurize not only the attic but the living space as well.

U.S. Product Literature



The Coleman Blend Air System

The product supplies 80-100 cfm to the attic and 30-50 cfm to the living space and sells for an installed cost of $U.S.350. The unit draws its outdoor air through the roof, distributes it through the heating system and, because the home is now pressurized, exhausts passively through existing kitchen and bathroom vents.[18]

CHAPTER EIGHT NOTES

1. Residential Standards 1980: for use by Canada Mortgage and Housing Corporation, issued by the Associate Committee on the National Building Code, National Research Council, Ottawa, NRCC no. 17304, 288 pages, paperback, price $1.50.

2. "Important Notice to Users of Residential Standards," NBC/NFC News, No. 107, February 1984, page 4.

3. Interview, Rick Bortolussi, Manager, CMHC National Office Support Centre, Ottawa.

4. Information on inspector training was obtained from Bob Player, general manager of CMHC's Technical Services Division in Ottawa.

5. Interview, Rick Bortolussi, National Office Support Centre, CMHC, Ottawa.

6. Standards for the Rehabilitation of Residential Buildings, CHMC, Ottawa, softbound, 34 pages, no date, free, NHA 5724 07/84.

7. Energy-Efficient Housing Construction, Canada Mortgage and Housing Corporation, Ottawa, 1982, paperback, 74 pages, $3. The quoted requirement is found on page 64. Aussi disponible en français sous le titre La construction de maisons efficaces au plan énergetique.

8. Condensation in the Home: Where, Why, and What to Do about It, Canada Mortgage and Housing Corporation, Ottawa, 1980, revised 1982, paperback, 30 pages/30 pages bilingual, no charge.

9. "Some Recommended Ventilation Methods," Moisture and Air: Problems and Remedies, page 20.

10. A copy of the guidelines is included in the Review of Technical Requirements for R-2000 Homes (Interim Report). For a summary of the requirements, see Chapter 7 Trade Practices in this report.

11. Bureau of Management Consulting, for Energy Mines and Resources Canada, Review of Technical Requirements for R-2000 Homes (Interim Report), Ottawa, January 1985.

12. Northern Residential Standards for Energy Efficient Housing, Draft 6, 1984. Intended for information and review only. The released version is entitled Measures for Energy-Efficient Northern Housing, Draft, March 1985. For more information, contact Mark Riley, Coordinator of New Housing Programs, Technology Transfer & Demonstration Programs Division, Energy Conservation and Oil Substitution Branch, Energy, Mines and Resources, 11th Floor, 460 O'Connor Street, Ottawa, Ontario K1S 5H3. Telephone (613) 995-1118

13. Commentary: Measures for Energy-Efficient Northern Housing, Draft 6, March 1985. For more information, see the preceding reference.

14. For information on the current status of the draft standard, contact the Working Group's chairman, Gren Yuill, G.K. Yuill and Associates Ltd., 1441 Pembina Highway, Winnipeg, Manitoba R3T 2C4 (204) 474-2461. The information given here is based on the draft standard released June 10, 1985.

15. Interview with Ted Tyne, Standards Administrator, Canadian Standards Association.

16. Interview with Brian E. Rossborough, Manager of Standards Program, Building Construction and Energy Standards Division, Canadian Standards Association.

17. Energy Design Update, the monthy newsletter on energy--efficient housing, Cahners Publishing Co., Boston, Vol. IV, No. 6, June 1985, page 3.

18. "'Mechanical Air Quality Devices' for Mobile Homes," Energy Design Update, June 1985, page 12-13.

In both the U.S. and Canada, the various publications of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) are widely referenced in building codes and used extensively in the design of ventilation systems. The current ASHRAE requirement for ventilation is Standard 62-1981 Ventilation for Acceptable Indoor Quality, replacing an earlier 1972 version.[1]

9.1 ASHRAE 62-81

Requirements

ASHRAE 62-81 specifes indoor air quality and minimum ventilation rates that will be acceptable to people and that will not impair their health while optimizing efficient energy use. The standard was written by an interdisciplinary committee of engineers, physicians, chemists and psychologists.

ASHRAE 62-81 allows either natural or mechanical ventilation, with the air uniformly mixed. When mechanical ventilation is used, provision for air flow measurement must be included. When natural ventilation and infiltration are used, the ventilation rate must be demonstrable. When infiltration is insufficient, mechanical ventilation must be provided.

When infiltration supplies all or part of the combustion air, the supply rate must be demonstrable; an appendix describes the method to be used.

Standard 62-81 specifies two alternate procedures to obtain acceptable indoor air quality, the first based on ventilation rates and the second based on maximum permissible concentrations of specified contaminants.

The Ventilation Rate Procedure provides various outdoor air requirements for institutional and commercial occupancies in litres per second per person and for residential occupancies in litres per second per room. It provides a procedure to determine whether the outdoor air is acceptable by listing maximum contaminant concentrations and gives methods for treating unacceptable air.

If proper air cleaners and adequate temperature control are provided, part of the air may be recirculated, but the outdoor air portion must never be less than 2.5 L/s per person, the amount considered necessary to dilute the CO_2 produced by metabolism and expired from the lungs with an adequate safety factor to account for health variations and some increased activity levels.

The residential ventilation rates shown here in Table 9.1 are independent of room size. They were derived from physiological considerations, subjective evaluations and professional judgements.

Table 9.1 ASHRAE 62-81 Ventilation Requirements

Area	Outdoor air L/s per room
General living areas	5
Bedrooms	5
All other rooms	5
Baths, toilets	25)installed capacity
Kitchens	50)for intermittent use

The Ventilation Rate Procedure is assumed to provide acceptable indoor air quality even though it offers only an indirect solution to the control of indoor contaminants.

The alternate Indoor Air Quality procedure provides guidelines for certain contaminants with no ventilation rates or air treatment methods. A list of maximum concentrations for specified contaminants is used for

objective measurement and a requirement of 80 percent agreement from a panel of at least 20 untrained observers is used for a subjective evaluation. The list of itemized contaminants is subject to periodic updating.

Status

ASHRAE 62-81 is in the process of being rewritten and a new version is expected shortly.

ASHRAE is also creating a committee to write a new standard on testing ventilation effectiveness. The purpose of ASHRAE Standard 129P is to provide a repeatable and accurate method of evaluating an air distribution system's ability to provide the required levels of ventilation in both office and residential buildings. The standard will cover measurements of both recirculated and make-up air but will not address the issue of indoor pollutants.[2]

ASHRAE is also in the process of revising Standard 90-1980 Energy Conservation in New Building Design, the model document for the National Research Council of Canada's Measures for Energy Conservation in New Buildings, 1983. As part of the revision, ASHRAE is writing a new Standard 90.2P Energy Design of New Residential Buildings, which is expected to provide separate energy system design requirements.[3] A draft document for public review is expected in late 1985.

ASTM

Another U.S. group involved in indoor air-quality standards is the American Society for Testing and Materials (ASTM).

In March 1985 a new ASTM subcommittee met for the first time to focus on the measurement of indoor air quality. It intended to consider a long list of pollutants plus measurements of the thermal environment, relative humidity, air movement, air exchange rates, wind and building characteristics.[4]

9.2 United States

Unless referenced otherwise, the following information on U.S. and European ventilation requirements is taken from two recent reports for the International Energy Agency that reviewed international practice in air-tightness and ventilation.[5,6]

Building codes throughout the U.S.A. are based on four model codes. The Southern Building Code is used predominantly in the southeastern states, the Uniform Building Code in the midwest and west, the National Building Code in the eastern states, and the Building Officials Conference of America (BOCA) code in the midwest and northeast. The responsibility for code choice lies with the states and their municipalities, resulting in over 2000 individualized codes. Some 46 states have now adapted requirements based on ASHRAE standard 90-75, prompted by federal incentives, and the recommendations in that standard are being adopted into the model codes.

The BOCA code is updated every three years. The current edition is 1984, with ventilation rates based on ASHRAE 62-81 but with lower requirements. Changes to the residential ventilation rates were passed at the 1985 annual conference and will become effective with the 1987 edition. As shown in Table 9.2, the new BOCA rates will closely match ASHRAE requirements.[7]

Table 9.2 BOCA Code Ventilation Requirements

Area	1984 Code	Proposed 1987 Code
	(given in cfm per person)	
General living areas	5	10
Bedrooms	5	10
Kitchens	20	100
Bathrooms	25	50/wc
All other rooms	-	10

source: Progressive Builder magazine

U.S. codes require anywhere from 3-15 ach capacity for intermittent use in kitchens, 0.5-2.0 for living rooms and 0.5-1.0 for bedrooms. For natural ventilation, the minimum opening area is typically 4-5 percent of the floor area.

The 1982 edition of the Uniform Building Code, for example, requires that rooms in dwelling units be provided with natural ventilation by openable exterior openings with an area not less than one-twentieth of the floor area with a minimum of 1.5 square feet for bathrooms and laundry rooms and a minimum of 5 square feet for all other rooms.[8] Mechanical ventilation may be provided in lieu of natural ventilation, with a capacity of 2 ach, one-fifth of which must come from outdoors. For bathroms and laundry rooms, the required rate is 5 ach. The Uniform Building Code is scheduled for change in 1986.

According to press reports, a new South Dakota code requires mechanical ventilation for housing financed under the state's housing authority. Such financing covers over 60 percent of the state's new houses.[9]

A summary of U.S. state energy codes has been published under the title The Directory and Compilation of Technical and Administrative Requirements in Energy Codes for New Building Construction Used within the United States - January 1984. It explains where the codes came from, what they require and how they are administered. It covers the background and technical basis for the codes, with criteria for low-rise residential, and for commercial and high-rise residential.[10]

9.3 European Countries

The International Energy Agency was established in 1974 as an autonomous body within the Organisation for Economic Cooperation and Development (OECD) to strengthen cooperation in the area of energy policy. Twenty-one countries are currently members.

The IEA sponsors research and development in a number of areas, including energy conservation in buildings. Infiltration has been targetted as the area needing the most work, and an Air Infiltration Centre with headquarters in England has been established to review world research and provide direction. Members are Canada, Denmark, Italy, Netherlands, New Zealand, Switzerland, Norway, Sweden, United Kingdom and the U.S.A.[11]

In some countries, several organizations compile standards and in some cases manuals of recommended practice assume the character of standards. In some countries, local requirements prevail and may vary.

Generally, minimum ventilation requirements were introduced to ensure good air quality indoors. The requirements are expressed in terms of air change, air flow and ventilation openings. In the case of new housing, the 1983 IEA report stated that there were no requirements for mechanical ventilation, although it may be called for in cases where natural ventilation is insufficient. Many countries have requirements for minimum flow and capacity. In the case of natural ventilation, there are requirements for open ventilator area, openable flaps and air flow. However, a U.S. periodical reported in December 1984 that the new French building code requires mechanical ventilation in all new housing.

It reported that virtually all new homes built in France in 1984 had some type of mechanical ventilation system. It reported too that a Swedish Council of Building Research survey of new houses in that country had shown "not a single house reported with natural ventilation. All had mechanical ventilation."[12]

9.3.1 Netherlands

Minimum ventilation requirements in the Netherlands are regulated in a Standard for Ventilation in Dwell-

ings. The minimum ventilation airflow rate is 7 dm^3/s per person (7 L/s per person). Range requirements are also specified for different rooms, as shown in Table 9.3.

The Netherlands has a Code of Practice in which these flow requirements are translated to openable window areas and sizes of ventilation ducts. A minimum ventilator opening of 1 m^2 is required with natural ventilation for each m^3/s specified.

For buildings with a height above 13 m, mechanical ventilation is required. Mechanical ventilation is also required when a kitchen is open to the living room with no door.

Table 9.3 Minimum Ventilation Requirements, Dutch Standard for Dwellings

Room	Minimum Air Flow	Min. Ventilation Opening (m^2)
Kitchens	21-28 dm^3/s	0.02-0.03
Bathrooms	14 dm^3/s	0.01
WC	7 dm^3/s	0.01
Living rooms	21-42 dm^3/s	0.02-0.04
Bedrooms	1 $dm^3/s\ m^2$	-

source: IEA reports [5, 6]

9.3.2 Sweden

According to the Swedish Building Code of 1980, dwellings are to be equipped with ventilation installations which permit continual air change, in addition to high-speed extraction, of at least 0.35 L/s per m^2 of the floor area. With a normal ceiling height of 240-250 cm, this is approximately 0.5 ach. Cross-sectional areas of ducts are specified for natural ventilation, ranging from 100-200 cm^2 depending on the room.

The minimum ventilation flow rate for kitchens is 10 L/s. For bathrooms and laundry rooms, the minimum requirement is 10 L/s with an additional 1 L/s for each m^2 above 5 m^2.[13] If there is no openable window in a bathroom or shower room, a high-speed extraction device is required with a capacity of at least 30 L/s and with an automati return to the basic flow rate. Minimum openings for natural ventilation are 0.02 m^2 for kitchens and 0.015 m^2 for bathrooms.

Natural ventilation in detached houses is permitted, even though the minimum air change rates may not be met under all weather conditions. However, natural ventilation may not be approved if radon daughter concentrations exceed the specified level. Sweden has a requirement that the annual mean concentration of radon decay products must not exceed 70 Bq/m^3 in areas continuously occupied by people.

Sweden also requires that ventilation shall ensure that sanitary problems do not arise from excessive concentrations of injurious or obnoxious gases.

Demands for airtightness in Sweden have meant that all new multi-family dwellings and nearly all new single-family dwellings have mechanical ventilation to fulfill the requirements for minimum ventilation and air quality.

A new Act on Physical Planning and Building was expected to come into force in 1985 and a revised version of the building code will then be issued.

9.3.3 Norway

According to the 1983 IEA report, Norway has no mandatory requirements for ventilation in housing, although recommendations exist for kitchens and bathrooms.[14] For kitchens 22 L/s is suggested for intermittent mechanical ventilation and for bathrooms the figure is 16 L/s. For natural ventilation in kitchens, 0.02

m^2 is the suggested minimum ventilator opening area; for bathrooms the figure is 0.015 m^2.[15]

According to the more recent 1984 review, Chapter 47 of the 1969 Norwegian National Building Regulations gives the requirements for ventilation in housing. The requirements are either a minimum cross-sectional area for ventilation ducts from different rooms when using natural ventilation, or a specified air flow rate for rooms with mechanical ventilation. An assumed air change rate of 0.5 ach is required when calculating ventilation heat losses.

9.3.4 Denmark

The Danish Building Regulations of 1982 applies to all new and existing buildings. Chapter 11 of the Regulations covers ventilation requirements. For residential buildings, fresh air supply should be by natural ventilation via exterior doors and windows. Exhaust air can be removed by natural or mechanical ventilation. Fresh air supply is defined in terms of area of ventilation openings and the rate of air exhaust is given in air flow in dm^3/s or by cross-section area of ventilation ducts, as shown in Table 9.4.

Table 9.4 Residential Ventilation Rates, Danish Building Regulations

Room	Fresh Air Supply Vent'n Opening	Exhaust Air: Natural Ventilation Duct Cross-section	Exhaust Air: Mechanical Vent'n Air Flow
	(cm^2)	(cm^2)	(dm^3/s)
Kitchens 7 m^2 plus	30	200	20
Kitchens under 7 m^2	30	150	15
Bathrooms	100	150	15
Living rooms	30	-	-

source: IEA reports [5, 6]

9.3.5 Switzerland

In Switzerland, each canton and several towns have their own building code. A move is underway by the Federal Office of Energy, in cooperation with the cantons and the Swiss Association of Engineers and Architects to standardize the building codes by working out a model code.

For residential buildings, recommendations exist only for interior bathrooms, toilets and kitchens -- typically 80-120 m^3/h (22-33 L/s) for kitchens, a minimum 60 m^3/h (17 L/s) for bathrooms with toilet, and a minimum of 30 m^3/h (8 L/s) for toilets.

9.3.6 Belgium

The current national standards issued by the Belgian Standards Institute are only mandatory for public buildings. They include a maximum ventilation rate of 1.5 ach per room. This standard is likely to be replaced by regional energy conservation standards. The Wallonia region is preparing a regulation for calculating the heat demand of a building in which the assumed air change rate is 0.75 ach. An existing heat loss calculation standard assumes an air change rate of 1 ach or 10-20 m^3/h/person in naturally ventilated buildings.

9.3.7 United Kingdom

The Building Regulations for England and Wales contain a requirement for mechanical ventilation rates for all building types for sanitary accommodation only,

but only as an alternative to natural ventilation. For natural ventilation, kitchens, bathrooms and bedrooms are required to have a minimum opening of 5 per cent of the floor area.

The Scottish Building Code has more specific requirements. For kitchens and bathrooms the requirements are 6 ach and 3 ach, respectively. For living rooms and bedrooms the requirement ranges from 3-8 dm^3/s (3-8 L/s) per person depending on room volume per occupant for which the room was designed.

In Inner London, the bylaws require natural ventilation by means of openable windows to all habitable rooms and kitchens plus a basic requirement for these rooms to have a permanently open ventilator of 2000 mm^2. Inspectors can approve mechanical ventilation where natural ventilation is not possible. The mechanical ventilation rate must be at least $22m^3/h$ (6 L/s) per occupant or 5 m^3/h (1.4 L/s) per square metre of floor area, whichever is greater. There is an unofficial requirement of 3 ach for bathrooms.

9.3.8 West Germany

Building laws and regulations are often issued jointly by the federal government and individual states, but it is the responsibility of the states to enforce the regulations.

A series of standards is concerned with ventilation. The Technical Health Principles covers indoor air quality and gives a minimum air flow rate of 20-30 m^3/h/person to maintain acceptable air quality. Ventilation Installations in Dwellings gives rates for dwellings with mechanical ventilation, as shown in Table 9.5.

Table 9.5 Minimum Mechanical Ventilation, West Germany

Room	Minimum Rate
Living rooms	1 - 1.5 ach
Bathrooms and toilets	6 ach
Kitchens (exhaust)	120 m^3/h
Internal bathrooms (exhaust)	60 m^3/h
Internal toilet (exhaust)	30 m^3/h

source: IEA reports [5, 6]

CHAPTER NINE REFERENCES

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2. "ASHRAE Recruiting Members for New Committee on Ventilation," Energy Design Update, June 1985, page 3. For more information, contact Carey Moore at ASHRAE headquarters, (404) 636-8400.

3. "ASHRAE Also Developing New Residential Energy Standard," Energy Design Update, June 1985, page 4.

4. ASTM News Release No. 12, undated. For more information, contact Ken Pearson, ASTM, 1916 Race St., Philadelphia, Pennsylvania, U.S.A. 19103. Telephone (215) 299-5520.

5. Elmroth and Levin, Swedish Council for Building Research, Air Infiltration Control in Housing: a Guide to International Practice, International Energy Agency, Energy Conservation in Buildings and Community Systems Programme, Air Infiltration Centre, Berkshire, England, 1983.

6. Catriona Thompson, A Review of Building Airtightness and Ventilation Standards, Document AIC-TN-14-84, Air Infiltration Centre, England, 1984.

7. Personal communication, John Hughes, Progressive Builder magazine, (603) 827-3347. For specific information on the BOCA code, contact Bill Evan, Public Relations Dept., BOCA Headquarters (312) 799-2300.

8. Uniform Building Code, 1982 edition, International Conference of Building Officials, Whittier, California. These ventilation requirements go back at least as far as the 1979 edition. They are listed under the heading of Light, Ventilation, and Sanitation -- a grouping that has not occurred in the Canadian National Building Code since the 1950's. The first Uniform Building Code dates from 1927.

9. "New South Dakota Law Mandates Superinsulation, Blower Door Tests, and Mechanical Ventilation," Energy Design Update, December 1984, p.1.

10. The Directory and Compilation of Technical and Administrative Requirements in Energy Codes for New Building Construction Used within the United States - January 1984, published by the National Conference of States on Building Codes and Standards Inc. (NCSBCS), Energy Programs Division, 481 Carlisle Drive, Herndon, Virginia 22070, telephone (703) 437-0100. Price $50 U.S.

11. Rob Dumont of the National Research Council's Division of Building Research in Saskatoon is Canada's representative on the IEA's Air Infiltration Centre.

12. "French and Swedes go for 100% Mechanical Ventilation in Houses," Energy Design Update, December 1984, p. 2. The article also reproduces a table showing that air-to-air heat exchangers were the least favoured system type (7%) while air-to-water heat pumps for domestic hot water and warm air heating were the most popular (52%).

13. A Review of Building Airtightness and Ventilation Standards gives these figures as per person. Page 15 of the English version of the Swedish Building Code confirms the figures as given here with no reference to the number of occupants.

14. Air Infiltration Control in Housing, page 73.

15. Air Infiltration Control in Housing, page 77.

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SECTION 9.33 VENTILATION

SUBSECTION 9.33.1. SCOPE

Ventilation

9.33.1.1. This Section applies to the ventilation of rooms and spaces in *residential occupancies* by natural ventilation and mechanical ventilation where the rated fan capacity does not exceed $2m^3/s$.

Mechanical ventilation

9.33.1.2. Where the rated fan capacity exceeds $2m^3/s$, mechanical ventilation shall conform to Part 6.

Ventilation of rooms and spaces

9.33.1.3. Ventilation of rooms and spaces in other than *residential occupancies* shall be in accordance with good engineering practice such as the procedures described in the ASHRAE Guide and Data Books and the ASHRAE Handbooks.

Ventilation of garages

9.33.1.4. A garage for parking more than 5 cars shall be ventilated in accordance with Part 6.

SUBSECTION 9.33.2. GENERAL

Ventilation of residential occupancies

9.33.2.1. Rooms and spaces in *buildings* of *residential occupancy* shall be ventilated by natural means in accordance with Subsection 9.33.3. or by mechanical means in conformance with Subsection 9.33.4., except that where a *dwelling unit* is heated with other than fuel-fired equipment within the *dwelling unit*, a mechanical exhaust system of 1 or more fans or blowers having a total capacity of at least $0.05\ m^3/s$ at a pressure differential of 2.5 mm of water shall be provided for each *dwelling unit*.

9.33.2.2. A space that contains a fuel-fired heating *appliance* shall have natural or mechanical means of supplying the required combustion air.

9.33.2.3. Where the ventilation system forms part of the heating system, Section 9.34 shall also apply.

Air contaminants

9.33.2.4. Air contaminants released within *buildings* shall be removed insofar as possible at their points of origin and shall not be permitted to accumulate in unsafe concentrations.

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Exhaust ventilation system

9.33.2.5. Every *building* in which dust, fumes, gases, vapour or other contaminants tend to create a fire or explosion hazard shall be provided with an exhaust ventilation system designed to conform with Part 6, and shall be provided with explosion relief devices and vents or other protective measures to conform with Part 3.

SUBSECTION 9.33.3. NATURAL VENTILATION

Minimum natural ventilation area

9.33.3.1. The unobstructed ventilation area to the outdoors for rooms and spaces in residential *buildings* ventilated by natural means shall conform to Table 9.33.3.A. Where a vestibule opens directly off a living or dining room within a *dwelling unit* ventilation to the outdoors for such rooms may be through the vestibule.

Table 9.33.3.A.
Forming Part of Article 9.33.3.1.

NATURAL VENTILATION		
Location		Minimum Unobstructed Area
Within *dwelling unit*	Bathrooms or water-closet rooms	0.09 m^2
	Unfinished basement space	0.2 per cent of the floor area
	Dining rooms, living rooms Bedrooms, kitchens, combined rooms Dens, recreation rooms and all other finished rooms	0.28 m^2 per room or combination of rooms
Other than within *dwelling unit*	Bathrooms or water-closet rooms	0.09 m^2 per water-closet
	Sleeping areas	0.14 m^2 per occupant
	Laundry rooms, kitchens, recreation rooms	4 per cent of the floor area
	Corridors, storage rooms and other similar public rooms or spaces	2 per cent of the floor area
	Unfinished basement space not used on a shared basis	0.2 per cent of the floor area
Column 1	2	3

Protection of openings supplying natural ventilation

9.33.3.2. Openings for natural ventilation other than windows shall be constructed to provide protection from the weather and insects. Screening shall be of rust-proof material.

SUBSECTION 9.33.4. MECHANICAL VENTILATION

Mechanical ventilation

9.33.4.1. Where rooms or spaces are mechanically ventilated, the system shall be capable of providing at least 1 air change per hour. Where a kitchen space is combined with a living area, natural or mechanical ventilation shall be provided in the kitchen area.

Air from dwelling unit

9.33.4.2. No air from any *dwelling unit* shall be circulated directly or indirectly to any other *dwelling unit*, *public corridor* or public stairway.

Exhaust ducts from toilet room and kitchen

9.33.4.3. Except for self-contained systems that serve individual *dwelling units*, *exhaust ducts* from rooms containing water closets, urinals, lavatories, showers or slop sinks, and *exhaust ducts* serving rooms containing cooking equipment, shall not be interconnected, and shall not be connected to duct systems serving other areas of the *building*, except at the inlet of the exhaust fan. Where such a connection is made, devices shall be installed to prevent the circulation of exhaust air through the *building* when the fan is not operating.

9.33.4.4. Where a *vertical service space* contains an *exhaust duct* that serves more than 1 *fire compartment*, the duct shall have a fan located at or near the exhaust outlet to ensure that the duct is under negative pressure, and such individual *fire compartments* shall not have fans that exhaust directly into the duct in the *vertical service space*.

Contamination from exhaust outlets

9.33.4.5. Air intakes shall be located so as to avoid contamination from exhaust outlets or other sources in concentrations greater than normal in the locality in which the *building* is located.

Exhaust discharge

9.33.4.6. *Exhaust ducts* shall discharge directly to the outdoors. Where the *exhaust duct* passes through or is adjacent to unheated space, the duct shall be insulated to prevent moisture condensation in the duct.

Access to ventilation equipment

9.33.4.7. Ventilation equipment shall be accessible for inspection, maintenance, repair and cleaning. Kitchen *exhaust ducts* shall be designed and installed so that the entire duct can be cleaned where the duct is not equipped with a filter at the intake end.

Air intake shield

9.33.4.8. Outdoor air intake and exhaust outlets shall be shielded from weather and insects. Screening shall be of rust-proof material.

Automatic damper

9.33.4.9. Outdoor air intake openings into the cold air return system shall be provided with a manually operated or automatic damper. Air intake openings larger than 127 mm diam shall be equipped with a manually operated closure if the system is gravity type, or an automatic closure if the system is mechanically operated.

9.33.4.10. Except as provided in Article 9.33.4.11., every ventilating duct shall conform to the requirements of Section 9.34 for *supply ducts*.

9.33.4.11. An *exhaust duct* that serves only a bathroom or water-closet room and that is contained entirely within a *dwelling unit* or space that is common to no other *dwelling unit*, may be of *combustible* material provided the duct is reasonably air tight and constructed of a material impervious to water.

9.33.4.12. Underground ventilating ducts shall be adequately drained. Such ducts shall have no sewer connections and shall be provided with access for inspection and cleaning.

SECTION 9.33 VENTILATION

SUBSECTION 9.33.1. GENERAL

Scope

9.33.1.1. This Section applies to the ventilation of rooms and spaces in *residential occupancies* by natural ventilation and to self-contained mechanical ventilation systems serving only 1 *dwelling unit*.

9.33.1.2. Mechanical ventilation systems serving more than 1 *dwelling unit* shall conform to Part 6.

Non-residential buildings

9.33.1.3. Ventilation of rooms and spaces in other than *residential occupancies* shall conform to Part 6.

Storage garages

9.33.1.4. A *storage garage* for more than 5 cars shall be ventilated in accordance with Part 6.

9.33.1.5. Rooms or spaces in *dwelling units* shall be ventilated during the non-heating season by natural means in accordance with Subsection 9.33.2. or by a mechanical ventilation system conforming to Subsection 9.33.3.

9.33.1.6. A space that contains a fuel-fired heating *appliance* shall be provided with combustion air in accordance with Section 9.34.

SUBSECTION 9.33.2. NATURAL VENTILATION

Minimum natural ventilation area

9.33.2.1. The unobstructed ventilation area to the outdoors for rooms and spaces in residential *buildings* ventilated by natural means shall conform to Table 9.33.2.A. Where a vestibule opens directly off a living or dining room within a *dwelling unit*, ventilation to the outdoors for such rooms may be through the vestibule.

Table 9.33.2.A.
Forming Part of Article 9.33.2.1.

NATURAL VENTILATION		
Location		Minimum Unobstructed Area
Within *dwelling unit*	Bathrooms or water-closet rooms	0.09 m^2
	Unfinished *basement* space	0.2 per cent of the floor area
	Dining rooms, living rooms Bedrooms, kitchens, combined rooms Dens, recreation rooms and all other finished rooms	0.28 m^2 per room or combination of rooms
Other than within *dwelling unit*	Bathrooms or water-closet rooms	0.09 m^2 per water-closet
	Sleeping areas	0.14 m^2 per occupant
	Laundry rooms, kitchens, recreation rooms	4 per cent of the floor area
	Corridors, storage rooms and other similar public rooms or spaces	2 per cent of the floor area
	Unfinished *basement* space not used on a shared basis	0.2 per cent of the floor area
Column 1	2	3

9.33.2.2.

Protection of openings supplying natural ventilation

9.33.2.2. Openings for natural ventilation other than windows shall be constructed to provide protection from the weather and insects. Screening shall be of rust-proof material.

SUBSECTION 9.33.3. MECHANICAL VENTILATION

Mechanical ventilation required

9.33.3.1. *Dwelling units* shall have a mechanical ventilation system capable of providing at least one half an air change per hour during the heating season, based on the interior finished volume of the *dwelling unit*. The system shall be controlled either manually by a switch or automatically. (See Appendix A.)

9.33.3.2. Where rooms or spaces in *dwelling units* are provided with mechanical ventilation systems in lieu of natural ventilation as required in Article 9.33.1.5., the systems shall be capable of providing at least 1 air change per hour where summer cooling is not provided or at least half an air change per hour where summer cooling is provided.

Make-up air

9.33.3.3. Mechanical ventilation systems for *dwelling units* shall include provision for introduction of fresh make-up air from the exterior.

9.33.3.4. Mechanical ventilation systems in combination with central heating or cooling systems shall conform with Part 6.

Exhaust discharge

9.33.3.5. *Exhaust ducts* shall discharge directly to the outdoors. Where the *exhaust duct* passes through or is adjacent to unheated space, the duct shall be insulated to prevent moisture condensation in the duct.

Access to ventilation equipment

9.33.3.6. Ventilation equipment shall be accessible for inspection, maintenance, repair and cleaning. Kitchen *exhaust ducts* shall be designed and installed so that the entire duct can be cleaned where the duct is not equipped with a filter at the intake end.

Air intake shield

9.33.3.7. Outdoor air intake and exhaust outlets shall be shielded from weather and insects. Screening shall be of rust-proof material.

9.33.3.8. Ventilating ducts shall conform to the requirements of Part 6 for *supply ducts*, except *exhaust ducts* that serve only a bathroom or water-closet room may be of *combustible* material provided the duct is reasonably air tight and constructed of a material impervious to water.

APPENDIX A

The Appendix to this document is included for explanatory purposes only and does not form part of the requirements. The bold-face reference numbers that introduce each item apply to the requirements in the Code.

A-9.33.3.1. Mechanical Ventilation. The tendency toward achieving higher levels of airtightness in housing and other concerns over energy conservation indicate that natural ventilation is not sufficient to ensure acceptable air quality during the winter heating season. The mechanical system required by this Article is, therefore, independent of natural sources, including windows and air infiltration.

This Article does not require that a centralized ventilation system by provided with duct work leading to all parts of the dwelling unit. The requirement may be satisfied by means of exhaust fans located in kitchen or bathroom areas where a fresh air inlet is provided at a location remote from the exhaust outlet. A ventilation system operating in conjunction with a central heating or cooling system comes under the jurisdiction of Part 6.

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PART 9
HOUSING AND SMALL BUILDINGS

SECTION 9.33 VENTILATION

SUBSECTION 9.33.1. GENERAL

Scope

9.33.1.1. This Section applies to the ventilation of rooms and spaces in ***residential occupancies*** by natural ventilation and to self-contained mechanical ventilation systems serving only 1 ***dwelling unit***.

9.33.1.2. Mechanical ventilation systems serving more than 1 ***dwelling unit*** shall conform to Part 6.

Non-residential buildings

9.33.1.3. Ventilation of rooms and spaces in other than ***residential occupancies*** shall conform to Part 6.

Storage garages

9.33.1.4. A ***storage garage*** for more than 5 cars shall be ventilated in accordance with Part 6.

9.33.1.5. Rooms or spaces in ***dwelling units*** shall be ventilated during the non-heating season by natural means in accordance with Subsection 9.33.2. or by a mechanical ventilation system conforming to Subsection 9.33.3.

9.33.1.6. A space that contains a fuel-fired heating ***appliance*** shall be provided with combustion air in accordance with Section 9.34.

★ **9.33.1.7.** If roughed-in plumbing is installed for the future installation of a water closet or urinal, provision shall be made for the future installation of the required ventilation.

★ **9.33.1.8.** On-site constructed fireplaces or factory-built fireplaces shall be considered fuel-fired ***appliances***. (See Section 9.22 for Combustion air.)

★ **9.33.1.9.** A supply of fresh air shall be provided for a ***residential occupancy*** and, if the ***building*** is heated by a forced air system, may be introduced at the return air duct upstream from the ***furnace*** fan.

★ **9.33.1.10.(1)** An outdoor air intake opening 0.008 m² or less in area into a return air system shall not be dampered.

★ **9.33.1.10.(2)** An outdoor air intake opening more than 0.008 m² in area but less than 0.033 m² in area into a return air system shall be equipped with a manually operated 50% damper.

★ **9.33.1.10.(3)** An outdoor air intake opening not less than 0.033 m² in area into a return air system shall be equipped with an automatic damper.

★ **9.33.1.11.** If a ventilating system exhausts air to the outdoors, provision shall be made for the admission of a supply of make-up air in sufficient quantity so that the efficiency of the exhaust system is not adversely affected.

SUBSECTION 9.33.2. NATURAL VENTILATION

Minimum natural ventilation area

9.33.2.1. The unobstructed ventilation area to the outdoors for rooms and spaces in residential ***buildings*** ventilated by natural means shall conform to Table 9.33.2.A. Where a vestibule opens directly off a living or dining room within a ***dwelling unit***, ventilation to the outdoors for such rooms may be through the vestibule.

Table 9.33.2.A.
Forming Part of Article 9.33.2.1.

NATURAL VENTILATION		
Location		Minimum Unobstructed Area
Within ***dwelling unit***	Bathrooms or water-closet rooms	0.09 m²
	Unfinished ***basement*** space	0.2 per cent of the floor area
	Dining rooms, living rooms Bedrooms, kitchens, combined rooms Dens, recreation rooms and all other finished rooms	0.28 m² per room or combination of rooms
Other than within ***dwelling unit***	Bathrooms or water-closet rooms	0.09 m² per water-closet
	Sleeping areas	0.14 m² per occupant
	Laundry rooms, kitchens, recreation rooms	4 per cent of the floor area
	Corridors, storage rooms and other similar public rooms or spaces	2 per cent of the floor area
	Unfinished ***basement*** space not used on a shared basis	0.2 per cent of the floor area
Column 1	2	3

9.33.2.2. Openings for natural ventilation other than windows shall be constructed to provide protection from the weather and insects. Screening shall be of rust-proof material.

Protection of openings supplying natural ventilation

SUBSECTION 9.33.3. MECHANICAL VENTILATION

9.33.3.1. ***Dwelling units*** shall have a mechanical ventilation system capable of providing at least one half an air change per hour during the heating season, based on the interior finished volume of the ***dwelling unit***. The system shall be controlled either manually by a switch or automatically. (See Appendix A.)

Mechanical ventilation required

9.33.3.2. Where rooms or spaces in ***dwelling units*** are provided with mechanical ventilation systems in lieu of natural ventilation as required in Article 9.33.1.5., the systems shall be capable of providing at least 1 air change per hour where summer cooling is not provided or at least half an air change per hour where summer cooling is provided.

9.33.3.3. Mechanical ventilation systems for ***dwelling units*** shall include provision for introduction of fresh make-up air from the exterior.

Make-up air

9.33.3.4. Mechanical ventilation systems in combination with central heating or cooling systems shall conform with Part 6.

9.33.3.5. ***Exhaust ducts*** shall discharge directly to the outdoors. Where the ***exhaust duct*** passes through or is adjacent to unheated space, the duct shall be insulated to prevent moisture condensation in the duct.

Exhaust discharge

9.33.3.6. Ventilation equipment shall be accessible for inspection, maintenance, repair and cleaning. Kitchen ***exhaust ducts*** shall be designed and installed so that the entire duct can be cleaned where the duct is not equipped with a filter at the intake end.

Access to ventilation equipment

9.33.3.7. Outdoor air intake and exhaust outlets shall be shielded from weather and insects. Screening shall be of rust-proof material.

Air intake shield

9.33.3.8. Ventilating ducts shall conform to the requirements of Part 6 for ***supply ducts***, except ***exhaust ducts*** that serve only a bathroom or water-closet room may be of ***combustible*** material provided the duct is reasonably air tight and constructed of a material impervious to water.

★ **9.33.3.9.** An enclosed ***exit*** stairway that serves more than one ***storey*** shall not be heated, ventilated or air-conditioned using an air system that serves other parts of the ***building***.

★ **9.33.3.10.(1)** In a ***residential occupancy*** all clothes dryer vents shall be ducted to the outside, and if clothes dryers are collectively vented, a sheet metal duct shall be provided and a continuously operating fan positioned upstream from all outlets to positively exhaust all moisture and lint.

★ **9.33.3.10.(2)** A screen is not permitted on a clothes dryer vent.

9.33.3.10.(3) Suitable access doors shall be installed in a clothes dryer vent for cleaning purposes.

★ **9.33.3.10.(4)** A clothes dryer vent shall not be connected to any other exhaust system, ***gas vent*** or ***chimney***.

STANDATA

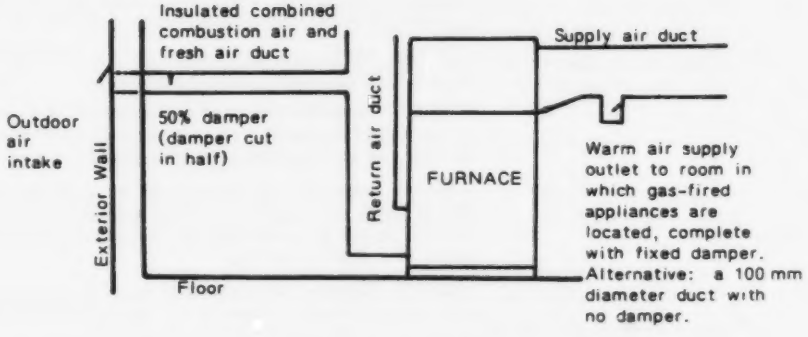
MAY 1984 81-T-015 (revised)

COMBUSTION AIR FOR DWELLING UNITS

This bulletin has been developed jointly by the Building Standards Branch and the Plumbing and Gas Safety Services Branch to clarify the requirements for combustion air for gas fired appliances that are installed in dwelling units.

The following two methods are acceptable to both branches and are deemed to satisfy codes and regulations that they administer with regard to installation of gas fired furnaces and hot water heaters in dwelling units. (Other methods that give equivalent performance may be accepted by the two branches.)

METHOD 1


Insulated combined combustion air and fresh air duct
Supply air duct
Outdoor air intake
50% damper (damper cut in half)
Return air duct
FURNACE
Exterior Wall
Warm air supply outlet to room in which gas-fired appliances are located, complete with fixed damper. Alternative: a 100 mm diameter duct with no damper.
Floor

The furnace fan should be run continuously (a two speed fan would be advisable) so that combustion air will always be available for the hot water heater.

The warm air supply outlet supplying the space in which the gas fired appliances are located must be provided with a fixed damper set at the required air volume for the appliances, however a 100 mm diameter duct with no damper is also acceptable.

Normally 10 volumes of combustion air are required for each unit volume of natural gas. In addition to combustion air an equal volume of dilution air is required unless the venting system were to produce the exact draft necessary for each appliance. For the majority of installations 20 volumes of combustion and dilution air need to be supplied to the dwelling unit for each unit volume of natural gas used by the appliances and this air must be brought into the space containing the appliance.

The sizing of the combined combustion air and fresh air duct and the air intake will depend on the quantity of air required for combustion air and for all other air requirements in the building.

ISSUE OF THIS BULLETIN IS AUTHORIZED BY THE DIRECTOR OF BUILDING STANDARDS

D O MONSEN, M R A.I.C

Alberta

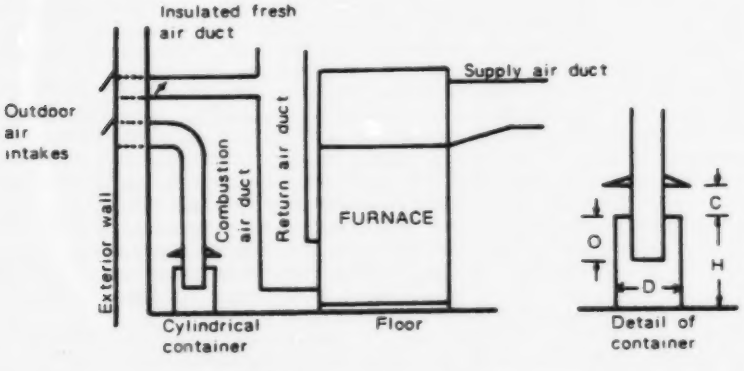
Building Standards Branch
707 - 10808 - 99 Avenue, Edmonton, Alberta, Canada. T5K 0G2

LABOUR
General Safety Services Division

The following table is for guidance only. It assumes that the combined combustion air and fresh air duct is short and has not more than 2 elbows or other restrictions to air flow (not including the 50% damper).

Appliances	Combined Input kW	Minimum size of Combined Combustion Air and Fresh Air Duct
One Furnace & One Hot Water Heater	up to 30	125 mm diameter
	over 30, not more than 45	150 mm diameter
	over 45, not more than 60	175 mm diameter
Two Furnaces & One Hot Water Heater	up to 60	125 mm diameter for **each** furnace
	over 60, not more than 90	150 mm diameter for **each** furnace

METHOD 2



The cylindrical combustion air container must be bottomless so that it can be lifted up to remove debris that may fall in. The container diameter D must be at least 75 mm larger than the diameter of the combustion air duct. The combustion air duct must not extend more than 150 mm into the container (dimension O). The height of the container H must be at least 300 mm. The conical shroud shall be fastened to the combustion air duct, shall have an outer diameter at least 75 mm larger than the container diameter D and the clearance between the bottom of the shroud and the top of the container C shall be not less than 100 mm and not more than 150 mm.

The combustion air duct must be sized to have an area of at least 450 mm^2/kW based on the input rating of all appliances that it will serve.

Warning: The above information about supply of combustion air for gas fired appliances does not take into account other appliances and spaces in the dwelling unit that must be supplied with either make-up or combustion air (examples include attached garages, fireplaces, wood stoves, clothes dryers, kitchen, washroom and other exhaust systems.)

NOTE: 15 kW = 50,000 Btu/h (approx.);
25 mm = 1 inch (approx.)

81-T-015/2
(revised)

CANADIAN
BUILDING DIGEST
DIVISION OF BUILDING RESEARCH • NATIONAL RESEARCH COUNCIL
CANADA

VENTILATION AND AIR QUALITY

by A. G. Wilson

UDC 697.95

Ventilation is the process of supplying or removing air, to or from a space, by either natural or mechanical means in order to maintain an acceptable level of air quality. The air supplied for this purpose usually comes from outside. A distinction can be made between intentional ventilation, which generally implies some form of manual or automatic control, and unintentional ventilation, commonly referred to as air leakage (CBD 23).

The need for ventilation usually results from the necessity to control the concentration of contaminants that may produce objectionable odours or toxic effects. Ventilation with untreated outdoor air is commonly used in non-airconditioned buildings to reduce discomfort from over-heating in summer and to prevent excessive relative humidities in winter (CBD 1). It is also used to improve occupational environments and to discharge heat, moisture and contaminants arising from industrial processes.

Ventilation needs depend on the occupancy and building use. Ventilation is essential if an adequate environment in buildings is to be provided; it usually involves a significant capital and operating expenditure. It is, therefore, an important consideration in building design.

The Ventilation Process

Ventilation may involve one or both of two processes. Where a source of contamination (including excessive heat and moisture) can be readily isolated, air can be exhausted from its immediate vicinity in such a way that contaminants are captured and directed into the exhaust system before they can diffuse into the occupied space. Good design is required to achieve an effective arrangement. This approach is widely used in industrial applications, an exhaust hood often utilized over cooking ranges being a common example.

Where an entire room is a source of contamination, an exhaust system may be used to isolate it from the rest of the building, as is often done with washrooms. In removing contaminants in this way, provision must be made for an adequate supply of replacement or "make-up" air.

In most situations the sources of contaminants, usually the occupants themselves and their activities, are not readily isolated. The ventilation process then employed is that of dilution. Fresh air is thoroughly mixed with the air in the occupied space and displaces an equal volume of room air, which is at the average room condition when it leaves the space. The net rate at which the contaminant is removed from the space by this process is equal to the quantity of air supplied multiplied by the difference between the concentration of the contaminant in the air leaving the space and that in the supply air. When the concentration of contaminants in the space has reached a constant level, i.e. at steady conditions, the rate of contaminant generation is equal to its rate of removal. If the air in the space is initially fresh, it will take some time after occupancy begins for the concentration of contaminants to approach a steady value because of the dilution effect of the original room air. The length of time will depend upon the room volume, the rate at which the contaminant is

produced (usually in proportion to the number of occupants), and the rate of fresh air supply. Because of this time effect, ventilation requirements are sometimes lessened as the volume of space per person increases.

The basic assumption in removing contaminants by the process of dilution is that their complete elimination is not necessary; a person can assimilate small quantities without any objectionable effects, or at least without any permanent injury. This concept is applied broadly in the field of industrial hygiene and is the basis of maximum allowable concentration values for short- and long-time exposures that have been developed for a wide range of contaminants. Application of the dilution principle can be readily illustrated in terms of the control of air contamination resulting from the normal respiratory process.

Control of oxygen and carbon dioxide levels

Fresh outdoor air contains about 21 per cent O_2 and 0.03 per cent CO_2 on a volume basis (the remainder being mainly nitrogen). Significant variations in these proportions can render it unfit for human use. For prolonged exposure a minimum concentration of 16 per cent O_2 and a maximum concentration of 0.5 per cent CO_2 (sometimes extended to 1½ per cent) are commonly accepted standards.

A person, when seated, usually inhales about 18 cu ft of air per hr. The exhaled air contains about 16 per cent O_2 and about 4 per cent CO_2. Thus, if only 18 cu ft per hr of fresh air were provided for each person in a continuously occupied space the concentrations of O_2 and CO_2 would approach these levels. Exposure for even a short time to a CO_2 level of 4 per cent would result in a temporary loss of vitality and ability. If, however, ten times this amount of fresh air were provided (180 cu ft per hr or 3 cu ft per minute), the ultimate CO_2 level would be only 0.4 per cent and the O_2 deficiency would be only 0.5 per cent, instead of 5 per cent. Approximately 3 cfm per person may thus be regarded as the minimum rate of supply of outdoor air, or equivalent, that is required to control within accepted limits the concentration of CO_2 arising from respiration of people at rest; only one tenth of this is required to maintain the required levels of O_2. Consumption of O_2 and production of CO_2 increase with activity, and ventilation requirements increase correspondingly. For people who are standing, the values are about 50 per cent higher than for those seated.

In the period immediately following the beginning of occupancy the volume of fresh air in the space has an influence on the time required for the concentration of CO_2 to reach a particular level. For example, with a fresh air supply of 3 cfm per person, the CO_2 level will essentially reach its final steady value in about 3 hr when there is 200 cu ft of space per person, and in about 30 hr when there is 2000 cu ft per person. With no ventilation but with good mixing of the room air and with 200 cu ft of space per person, the CO_2 will reach a level of 0.5 per cent in about 1 hr after the space is occupied.

For many kinds of spaces and occupancies, supplies of outside air in excess of that required to control the effect of respiration on O_2 and CO_2 levels occur through uncontrolled infiltration and exfiltration. In single-family residences, for example, air leakage, with windows closed, usually amounts to at least one complete change of air every 4 hr; assuming 2000 cu ft per person this leakage amounts to about 8 cfm per person. In a crowded classroom, with only 200 cu ft per person, a supply of uncontaminated air equivalent to one air change per hr is required to provide 3 cfm per person and air leakage may not always provide this amount.

Ventilation rates greater than this are required to control odours and, where cooling is not provided, to offset heat gains, which include body heat losses. If windows can be opened, they usually will be opened in response to an awareness of stale air or excessive temperatures before CO_2 levels exceed accepted limits.

CO_2 and other gases, particularly CO and water vapour, are generated in the process of combustion. Where unvented combustion heating devices are used, it is necessary to estimate carefully the volumes of contaminants produced and to ensure that there is sufficient ventilation to keep the concentrations within established limits. This problem arises, for example, with enclosed garages where each automobile generates about 35 cu ft per hr of CO with motor running. Only very low levels of CO can be tolerated; a maximum value of 0.02 per cent is sometimes specified for 8-hr exposure, and 0.1 per cent for short-term occupancy. These call for ventilation rates of about 3000 and 600 cfm respectively for each car which for average conditions, may require fresh air equivalent to 10 or more air changes

per hour. This represents a substantial expenditure for energy if the garage is heated in winter.

Control of Odours

The control of odours determines requirements for fresh air, or its equivalent, in most spaces accommodating human activities. The sources are many: body odours and tobacco smoke will usually be the most objectionable in offices or places of assembly; food preparation and garbage are frequent contributors; odours may come from finishing materials and furnishings and even the wetted coils of air conditioning systems as they become dirty; and the outdoor air itself may be an important source in areas where there is serious air pollution.

Although odorants are not the cause of organic disease, obnoxious odours may cause temporary ill effects, including nausea, impaired respiration and insomnia. The nose is extremely sensitive and very small concentrations can be objectionable. Odour perception is greatest on initial exposure and the nose may subsequently become desensitized. It may not, therefore, detect a gradual increase in odour concentration, although the effects may still be felt. Air that seems to be stale or stuffy is usually contaminated with an assortment of odours associated with human activities, and may produce depression rather than the sensation of a specific odour.

Standards of maximum odour concentration for occupied spaces have not yet been developed because of the difficulty of identifying and measuring the various odour producing vapours, and of relating the measurements to human response. Instead, building codes and other design guides currently specify minimum rates of fresh air supply, or equivalent, required for various kinds of occupancies, usually in terms of cubic feet per minute per person, to provide adequate dilution. These values are based on both the results of laboratory studies of the subjective reactions of people and on experience. The rates required are dependent upon the kind of activity and amount of smoking, and vary from 5 to 50 cfm per person; a range of 10 to 30 cfm per person covers the majority of situations. Values are sometimes adjusted for the volume of space per person although this is now regarded as a questionable practice except for transient occupancy; the time after initial occupancy during which the original volume of air in the room influences the concentration levels is reduced as the rate of ventilation increases.

It is necessary to supply fresh air in a manner that will ensure good mixing with the room air. In buildings with mechanical ventilation systems this is accomplished by blending the outdoor air with a larger quantity of air from the building and distributing the mixture to the space (CBD 106). The air brought in from outdoors must be heated in winter. In centrally air conditioned buildings, the mixture is processed in the plant to handle the heat and moisture loads of the space (CBD 109), the total amount of air that must be circulated being determined by these loads. Typical rates of total air circulation for office air conditioning are 1 to 2 cfm per sq ft of floor area, with about 15 per cent of this being outdoor air. These values vary widely, however, with the type of occupancy and construction. Although not necessarily regarded as good practice, it is not uncommon to reduce the proportion of outdoor air during periods of peak heating or cooling requirements in order to reduce the load on the plant.

Because of the cost of conditioning outdoor air, and because of increasing pollution levels in some areas, the designer may wish to give consideration to the conditioning of indoor air with odour removing equipment as an alternative to ventilation with outdoor air. This can take a number of forms, the one most widely applied to building air conditioning being adsorption by activated charcoal. This material is supplied in pellet form and applied as a bed through which the air stream passes. Performance can be varied through the design of the bed and the selection of the material. When the charcoal has adsorbed its full capacity of odorants, it is usually returned to the manufacturer for regeneration and replaced with fresh charcoal. The design of such a system would normally be based on established requirements for outdoor air. For example, if outdoor air requirements for odour control amount to 20 per cent of the air being circulated, processing all of the circulating indoor air with an odour controlling device that is 20 per cent effective would give comparable results. Outdoor air would, however, normally be required in sufficient quantity to maintain CO_2 levels within acceptable limits. In unusual situations where outdoor air is not available, such as in submarines, the CO_2 levels can be controlled by chemical treatment.

Control of Airborne Particles

A variety of airborne particles, such as dust, smoke, pollens and organisms, are contained in the outdoor air brought in for ventilation while others are brought indoors or generated by the activities of the occupants. Limiting the concentrations of these contaminants is another important aspect of air quality control; it involves primarily the special technology of air cleaning which is beyond the scope of this Digest. The total rate of air circulation determines the rate at which particles are gathered by the air cleaning equipment and is, therefore, a factor in the degree of air cleanliness achieved. Ventilation can be a significant factor in reducing the concentration of fine air-borne particles generated indoors, such as those in tobacco smoke. Control of dusts evolved in industrial processes may be effected with exhaust-hood arrangements.

In hospitals, where the control of infection from airborne sources is of special importance, ventilation is used to provide positive pressures in spaces containing patients prone to infection and negative pressures in spaces containing patients with highly communicable diseases. It is common practice also to circulate a high proportion of outdoor air, up to 100 per cent, in areas such as operating rooms. This results in a particularly high heating and cooling load for ventilation and leads designers to consider the economics of heat recovery devices in the exhaust air stream.

Ventilation and Summer Cooling

In buildings without air conditioning systems, ventilation with outdoor air is utilized in summer to dissipate the internal heat gains and that from solar radiation. In hot weather, inside conditions will be tolerable only if indoor temperatures are not allowed to exceed those outdoors by more than a few degrees. Buildings without air conditioning should, therefore, be designed to minimize heat gains and to provide high rates of ventilation; for example, the equivalent of 30 or more air changes per hour. This can usually best be achieved with large openable window areas arranged for ventilation through the occupied zone. The flow of air past occupants provides an additional measure of relief by increasing convective heat losses.

Commercial and institutional buildings are sometimes designed with air handling systems intended for future air conditioning but which provide only mechanical ventilation initially. Ventilation quantities supplied by this means will almost always be inadequate for the relief of summer heat and unless additional ventilation is available through openable windows, conditions will probably be intolerable on warm days.

Conclusion

Adequate ventilation of occupied spaces with outside air, or its equivalent, is a basic requirement for achieving acceptable environmental conditions within buildings. Unless it is provided, the quality of the environment and the well-being of the occupants will suffer. It is, therefore, an essential element in the design of a building and its services. The components incorporated in buildings for ventilation usually involve some additional capital expenditure; the heating and cooling load represented by outdoor air involves a significant operating expense. In special situations the use of air purifying or heat recovery equipment may provide some economic options. Good design, therefore, requires a knowledge of the factors determining ventilation requirements and the ways in which the purposes of ventilation are achieved.

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Division of Building Research

CANADIAN BUILDING DIGEST

THE REGULATION OF BUILDING CONSTRUCTION

by A. T. Hansen

Abstract

Federal, provincial and municipal building construction regulations are summarized. Common terminology is defined. The relationship between model codes and regulations is discussed.

Introduction

Buildings are regulated by a variety of codes, standards, bylaws, regulations, and acts which can vary from province to province and from municipality to municipality. Because of the array of requirements, it is important that the designer be aware of which requirements must be satisfied at an early stage, so that later expensive changes can be avoided.

Under Canadian law, the regulation of building construction is the responsibility of provincial governments, who in turn can delegate this power to their municipalities. The federal government, however, can also become involved in building regulations in a secondary role when an act (such as the National Housing Act) requires that buildings be built to certain standards in order to qualify for the provisions of the Act. Another federal act, the Hazardous Products Act, regulates a number of building products to limit their risk in relation to fire, health or personal injury. These products include cellulose insulation, urea formaldehyde foam insulation, carpeting, furnishings, smoke alarms and glass used in doors. Regulations under this act take precedence over provincial acts, although provincial requirements can still apply if they are not in conflict.

Common Terminology

Acts are the legal statements passed by a legislature or parliament that empower the government to carry out particular objectives. These acts are often referred to as the enabling legislation. The terms of an act may give the government the authority to provide regulations to complement the act. In the case of building regulations, the administering authority may prepare these additional regulations utilizing existing published codes and standards to the extent that this is practical (and amend them as necessary). The National Building Code, the National Fire Code, the Canadian Plumbing Code, the Installation Code for Natural Gas Burning Appliances and Equipment and the Canadian Electrical Code are examples of such codes. The regulations in their altered form may then bear the name of the province (e.g. the Manitoba Fire Code). The provincial acts in some provinces may merely give the municipalities authority to adopt a code, or they may require the municipalities to adopt a particular code.

Code requirements often reference other codes and standards since it is not practical to include all of this material in the same code. The National Building Code (NBC),[1] for example, references over 190 different codes and standards published by seven different standards writing agencies. Some of these are as voluminous as the NBC itself, and may in turn reference additional documents.

The terms "codes" and "standards" are commonly used interchangeably. In general, a document is referred to as a code if its title proclaims it as such. Although there appears to be little philosophical difference between the two types of documents, the term "code" is generally restricted to larger and more complex documents. (Some U.S. reference documents proclaim themselves as "specifications". In Canada, however, this term is generally restricted to designers' documents that supplement the information provided on plans and drawings.)

DBR
Canada

CBD 237
March 1985

Laws passed by municipalities are bylaws. The authority that a municipality can exercise depends on the enabling legislation under which it operates. In provinces that have adopted provincial building regulations, for example, municipalities are usually not permitted to pass bylaws that contravene the spirit of the provincial act.

Building Codes

Building codes are generally concerned with matters affecting fire safety, structural sufficiency and health. They are intended to apply to the construction of new buildings and the demolition or relocation of existing buildings. They are also intended to apply when the use of a building changes or if the building is significantly renovated or altered.

The National Building Code was first published in the early 1940's to encourage reasonable and uniform standards for health and safety in buildings. It is a model, and has no legal status unless it is adopted by an authority having the power to regulate buildings.

Prior to the 1970's, provinces generally delegated the responsibility of regulating buildings to municipalities. During the last decade, however, provincial codes began to replace municipal building bylaws. Most provinces now have acts to regulate building construction, and the regulations under these acts are based in whole or in part on the NBC. In provinces without provincial building regulations, the NBC is usually the basis for municipal building bylaws either by choice of the municipality or as a condition under a provincial act.

Building codes are increasingly being used to achieve objectives beyond the traditional concerns of health and safety. Most building codes (including the NBC) now contain requirements designed to make buildings more accessible to the disabled. Some provincial building codes also contain requirements related to energy conservation, although these have not been included in the NBC. Instead model energy conservation requirements have been issued under separate cover.[2] (In Quebec, a separate act regulates energy conservation in buildings and the regulations under the act are based on these model requirements).

In addition to numerous references to other codes and standards, the NBC makes frequent references to its supplement[3] which contains climatic and seismic information for various municipalities across the country, enabling the code to be applied in these areas. It also contains information on the calculation of fire resistance, various measures for achieving fire safety in high buildings, and explanatory material relating to structural design requirements. Additional explanatory material on fire safety is available in a separate publication.[4]

Specialized structures such as farm buildings and mobile homes may be regulated under building code provisions or through separate acts that may utilize codes or standards specifically written for such structures.

While the application of building codes to new buildings is fairly straightforward, their application to existing buildings (in the case of change of use, rehabilitation or repairs) may not be.[5] It is for this reason that some provinces have special provisions in their regulations to deal specifically with existing buildings. These provisions generally permit a relaxation of the requirements that would otherwise apply, while maintaining an acceptable level of safety.

Fire Codes

Fire codes generally apply to buildings already in use. They regulate the conduct of activities that cause fire hazards. They regulate the maintenance of fire safety equipment and egress facilities, the combustibility of furnishings, and the storage of flammable and combustible materials (and other dangerous products). They require the establishment of fire safety plans in the event of emergencies. Some also provide for the upgrading of existing buildings. The objectives of the requirements are to prevent fires, particularly those that may present a hazard to the community, and to limit damage should fire occur.

Fire codes and building codes have a number of common objectives, and are usually developed cooperatively to ensure compatibility. Unlike building codes, however, fire codes may contain certain retroactive requirements. That is to say, certain requirements are intended to be applied to all buildings, regardless of when they were built. Since the designs of these buildings vary widely, the enforcing authority must exercise judgement to apply the requirements judiciously.

The National Fire Code (NFC), now in its fifth edition,[6] was first published in 1963 to encourage uniformity in fire prevention bylaws. It is used in most provinces either as the basis for regulations under the various fire prevention acts or as guidelines for authorities who administer these acts. Where provin-

cial fire codes have not been adopted, the NFC forms the basis of many municipal fire prevention bylaws.

While building codes are generally administered by building departments, fire codes in most provinces are administered by the fire services. Each province has a fire marshal or fire commissioner (or the equivalent) whose office is generally responsible for administering fire prevention acts. (In Quebec, the role of the Directeur général de la prévention des incendies is somewhat different.) The municipal fire service normally acts on behalf of the fire commissioner or fire marshal to enforce fire prevention regulations. The specific roles of the building and fire departments vary from province to province, but generally both cooperate in areas of common interest.

Residential Standards

The Residential Standards is used as the minimum standard for housing constructed under the National Housing Act. The Canada Mortgage and Housing Corporation (CMHC), who administers the Act, uses the Standards to help achieve its objective of improved housing and to protect its financial interest. The current Residential Standards[7] therefore protect the resale value of the building. In addition to requiring compliance to the NBC, the Standards regulate such things as kitchen cabinets, closets, storage areas, landscaping and painting. Participants under the National Housing Act are required to conform to the Standards as well as to the applicable provincial or municipal requirements. From time to time CMHC amends or adds to the Standards requirements, usually through its "Builders' Bulletins".

Each province also maintains "housing corporations" to administer provincial housing programs and provide input into joint federal-provincial programs. They may also own and administer public housing constructed to fill particular provincial objectives. Provincial housing corporations may have additional construction requirements aimed at providing greater durability or lower maintenance and operating costs. Municipalities may also have their own housing maintenance bylaws that apply to existing residential buildings.

Zoning Laws

Municipalities are generally permitted by provincial acts to enact municipal zoning bylaws. Generally administered by planning departments, the bylaws control the appearance, use and character of neighbourhoods within a municipality. They regulate such things as building size, land use (including type of occupancy), front and side yard clearances, population density and sometimes even landscaping and the exterior appearance of buildings.

Other Codes and Standards

While the bulk of requirements that regulate building construction are contained in building and fire codes, buildings may also be subject to other acts targeted for specific building types or occupancies. Other acts may regulate particular services or equipment in buildings that are not directly regulated by provincial building codes.

Provincial liquor licencing acts, for example, may contain certain building requirements that have to be met before a licence is granted. Other acts may be aimed at providing a minimum level of fire safety in certain classes of buildings (such as hospitals, theatres, schools, or apartments), when it is considered that they are not adequately covered in existing provincial fire prevention acts.

Plumbing may also be regulated by a separate act. The Canadian Plumbing Code contains model plumbing requirements,[8] which are used by a number of provinces and municipalities as the basis for their plumbing regulations or bylaws.

Electrical installations are often administered by a separate department. In some provinces the provincial electrical utilities administer the requirements on behalf of the government.

The Canadian Electrical Code, Part I, is used by all provinces as the basis for their provincial electrical regulations. Like other model codes, it has no legal status unless adopted by an authority having the power to regulate electrical installations. First published in 1927, the CEC is now in its 14th edition.[9]

Separate provincial acts may control the installation and maintenance of other building services and equipment, such as gas installations, elevators, escalators, moving walkways, pressure vessels and, in Nova Scotia, sprinkler systems. The regulations under most of these acts rely on codes and standards published by standards writing agencies.

Since different acts may have different objectives, the requirements contained in their regulations differ and in some cases may even conflict with one another. Where more than one act regulates the same building, however, the general principle is that each must be satisfied. (There is an ongoing program in most provinces to minimize overlapping regulations and remove conflicts.)

Codes and Standards Writing Agencies

The National Research Council of Canada, through its Associate Committee on the National Building Code, is responsible for producing the National Building Code, the Canadian Plumbing Code, the Canadian Farm Building Code, the Measures for Energy Conservation in New Buildings, the Residential Standards and other code-related documents. Another NRCC committee, the Associate Committee on the National Fire Code, is responsible for the National Fire Code. Unlike other codes and standards writing organizations, NRCC is essentially a federally funded research agency. It does not operate a general standards writing organization, nor does it provide a certification and listing service for building products.

The Canadian Standards Association produces most of the codes and standards referenced in the National Building Code including the Canadian Electrical Code. CSA is a non-profit, non-government agency that not only prepares standards but maintains a testing, certifying and listing service for various products including electrical products.

The Underwriters' Laboratory of Canada is also a non-profit, non-government standards writing agency providing a testing, certification and listing service. ULC standards generally apply to products or systems related to fire safety.

The Canadian General Standards Board is a government-sponsored agency operating under Supply and Services Canada. Originally conceived to prepare specifications for government purchasing requirements, it currently operates as a national standards writing body preparing standards for general use in a variety of fields.

Gas appliances and installation standards are prepared by the Canadian Gas Association who also test, certify and list gas-associated products.

Standards produced by the American Society for Testing and Materials and the National Fire Protection Association are also referenced in regulations or codes where there is no acceptable Canadian equivalent. NFPA produces many standards in the fire protection field and, like ASTM, has an international reputation for excellence. Both NFPA and ASTM are non-profit agencies operating in the private sector.

Concluding Remarks

Since buildings are subject to a variety of regulations that can influence their design, it is important to know as early as possible those which must be accommodated. It can be useful, therefore, for the designer to consult with appropriate administrative officials early in the design stage. The more complex the design, the more important these consultations become. Although officials cannot assume design responsibilities, their advice can provide valuable assistance to the designer in appreciating the various regulations that apply.

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* National Research Council of Canada, Ottawa, Ontario

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R2000 Home Program Guidelines For The Design and Installation of Ventilation Equipment

1. Scope

This standard covers equipment and installation guidelines for mechanical ventilation systems in R2000 homes. This includes heat recovery ventilators that comprise elements in which heat is transferred between two isolated air streams. Ventilators shall have a maximum rated capacity of not less than 100 CFM (50 l/s) or .5 airchanges per hour (ACH) whichever is greater.

2. Definitions

The following definitions apply in this standard:

Net Ventilation means the amount of outdoor air entering the building through the heat recovery ventilator.

Balanced System means a ventilation system in which the flow rates of the exaust air leaving the building is equal to the supply air entering the building as measured at the heat recovery ventilator within +/- 10%;

Heat Recovery Ventilator (HRV) means a factory assembled unit which contains elements in which heat is transferred between two isolated air streams. This unit or equipment has been previously referred as an air-to-air heat exchangers;

Hoods means exterior wall terminals for the supply air inlet and the exhaust air outlet;

Purchaser means the person or persons having ownership or control of the home at a date no later than two weeks following the start-up or sooner;

Qualified means acceptable to the regulatory authority;

3. Equipment

Ventilator equipment shall be certified to the requirements of CSA Standard C22.2 No. 113 Fans and Ventilators.

Ventilators shall have a maximum rated capacity of not less than 100 CFM (50 l/s) or .5 airchangers per hour (ACH) whichever is greater.

Ventilators shall be accompanied by up-to-date, clear, correct and comprehensive instructions and pertinent tables or graphs for:

(a) determining performance at other than rating conditions;
(b) properly installing the equipment including air distribution for providing delivered air in accordance with Chapter 32 of the ASHRAE hanbook of Fundamentals 1981;
(c) trouble-shooting malfunctions;
(d) informing the purchaser about all aspects of operation, minor trouble-shooting, routine maintenance, seasonal operation and providing an up-to-date parts list with suppliers. This information shall be provided as a separate manual;
(e) method of balancing and air flow measurement;
(f) label(s) intended to be affixed to any component of the system which requires a "caution, cleaning and/or maintenance";
(g) the range of outdoor design temperatures at which the equipment is designed to operate;

An installation kit including vibration isolation means for both equipment and duct connections shall be made available, if not provided as an integral part of the equipment, and shall be included on the parts list referred to above.

Heat recovery ventilators shall be equipped with automatic, self-defrosting means if the equipment design is such that air flow restriction due to icing may occur.

All ducts and connectors shall conform with ULC Standard 181-1981 Factory-Made Air Ducts and Connectors.

4. Systems Requirements

The system application shall meet the requirements of all applicable bylaws, codes, regulations and standards.

The system shall be applied to provide net fresh air ventilation rates, and as a minimum shall be not less than 100 CFM (50 l/s) or the capability to deliver 1/2 air change per hour, which ever is greater, for the building and verified by test measurements after installation.

The system shall be applied to provide distribution of fresh air within the building to each room of the house. A capability of 5 l/s (10 cfm) is regarded as the absolute minimum for any room.

Peak ventilation rates higher than that specified above may be provided according to the needs of the application.

The installation of at least R.S.I. 0.7 (R-4) insulation with vapour barrier shall be required for any ducts leading to and from the equipment to the outside, and must be sufficient to avoid the accumulation of moisture on the outside surface of the duct and the ventilator.

Warm air ducts shall be insulated againts heat loss if located in an unheated area.

Heat recovery ventilators shall not be directly connected to any other appliance such as a clothes dryer, range hood exhaust or heating system, unless specifically approved by a regulatory authority.

Heat recovery ventilators shall require a minimum 1/2 in. nomimal pipe size condensate drain, pitched in the direction of flow and shall have a trap or a condensate pump with sufficient capacity; in both instances, free condensate flow to a building drain must be achieved if necessary according to the manufacturer's instructions.

Heat recovery ventilators and all condensate lines must be installed in a space where the temperature is maintained above the freezing point.

Two or more units shall not be connected in parallel air flow to a common air duct system, unless specifically approved by a regulatory authority.

5. System Installation

The installer shall adhere to all applicable bylaws, codes and regulations, as well as specifications detailed by the manufacturer, wholesaler or distributor, and CSA Standard C22.1.

The equipment shall be installed to minimize any noise problems, and shall use the components from the installation kit referred to in Section 3.

All procedures recommended by the manufacturer of the equipment for start-up, including air balancing and air flow measurement shall be followed. As proof that all start-up steps including air balancing and air flow measurements have been done, the start-up mechanic shall complete and sign the pertinent section of Form A as shown in appendix A.

The R-2000 Equipment Ventilation Installation Report, Form A, shall be completed and copies distributed to the purchaser, manufacturer, contractor/distributor and the CHBA R-2000 program authorities.

Filter(s) should be installed in accordance with the manufacturer's instructions. Clean air filter(s) shall be installed at start-up.

Access shall be provided for cleaning and servicing without moving the unit or requiring the use of special tools.

Outside supply and exhaust hoods shall be separated a minimum of 6 feet (2 m) and at least 8 inches (200 mm) from the bottom of the hoods to the finished ground grade. The hoods shall be installed to minimize cross-contaminations from other sources and the effects of weather.

Intake and exhaust ducts and hoods between the ventilator and the outside wall shall be properly and correctly caulked and shall be properly sealed with an air vapour barrier. The hoods shall be sized to accommodate the ducts to which they are connected and must be identified as to which duct and hood is intake and which is discharge.

The ductwork shall be installed by qualified personnel.

Indirect connections to an opening or branch of a return air duct of a forced air heating system heating system shall be positioned no further than 12 in. (300 mm) from said opening, and shall be sized and located in accordance with the manufacturer's instructions. The furnace must be capable of running continually at a low speed setting compatible with acceptable comfort levels.

A means of balancing air flow in branch ducts shall be provided.

Any power wiring shall be installed by qualified personnel.

All of the control wiring and power wiring connections shall be thoroughly checked out at start-up.

All workmanship shall be of good calibre and in accordance with accepted industry practices and standards.

All ductwork and wiring shall be properly supported or clipped to prevent sagging, excessive movement or an unsightly installation.

Auxiliary condensate drains shall be installed where recommended by the manufacturer.

The system shall be adjusted for proper balanced air flows or specified interior, exterior pressure differences using measuring instruments with an accuracy of +10%. The supply

and exhaust air flow rates shall be within +10% of each other, unless otherwise specified in an approved design and the results shall be recorded on Form A. The recorded flow rates shall be within +10% of each other, unless otherwise specified by design.

In cases where balancing and air flow tests conducted by program monitoring personnel differ by 30% or greater from the results of the installer and results in the system no longer meeting the program requirements, remedial action must be initiated by the installer to meet the program requirements.

All components and accessories of the system shall be the manufacturer's approved combinations.

The purchaser shall be given the manufacturer's operation, maintenance information, and all information on special controls.

A sticker shall be affixed to all elements of the unit which require "caution, cleaning and/or maintenance".

The installer shall review the system operation with the first purchaser who shall also be advised of the need to verify that an adequate supply of combustion air is available for all combustion equipment including fireplaces. It will also be recommended that he have a qualified organization and mechanic perform this verification.

SECTION 33. VENTILATION AND HEAT RECOVERY

A. SCOPE

(1) NBC This Section applies to the ventilation of rooms and spaces in residential occupancies by natural ventilation and to self-contained mechanical ventilation systems serving only 1 dwelling unit.

(2) Mechanical ventilation systems serving more than 1 dwelling unit shall conform to this Section and to Part 6 of the NBC.

(3) NBC A storage garage for more than 5 cars shall be ventilated in accordance with Part 6 of the NBC.

(4) Where the ventilation system forms part of the heating system, Section 34 shall also apply.

(5) For provision of air to combustion appliances, see Section 34.

B. GENERAL

(1) Ventilation adequate to maintain air quality at acceptable levels for occupants shall be provided to rooms or spaces within dwellings, either by means of a natural ventilation system, in conformance with Subsections C and E, or by a mechanical ventilation system in conformance with Subsections D and E.

(2) Appliances that are designed to discharge the products of combustion to the outdoors through a flue shall be supplied with air in accordance with Subsection 34C and shall be isolated from dwelling spaces in accordance with Subsection 34D.

(3) Where mechanical equipment is provided which exhausts or supplies air to a dwelling, but which does not satisfy the air change requirements of D(1), all of the requirements of Subsection C shall be met.

(4) Where air contaminants may be released within a building, the ventilation system shall be designed to remove them, insofar as possible, at their points of origin, and they shall not be permitted to accumulate in unsafe concentrations. This requirement shall include appliances such as gas refrigerators or portable kerosene heaters that are designed to operate without discharging the products of combustion to the outdoors through a flue.

(5) Every building in which dust, fumes, gases, vapour or other contaminants tend to create a fire or explosion hazard shall be provided with an exhaust ventilation system designed to conform with Part 6 of the NBC, and shall be provided with explosion relief devices and vents or other protective measures to conform with Part 3 of the NBC.

(6) No air from any dwelling unit shall be circulated directly or indirectly to any other dwelling unit, public corridor or public stairway.

(7) Where air is introduced into any room or space, provision shall be made for it to leave that room or space.

C. NATURAL VENTILATION SYSTEMS

(1) The unobstructed ventilation area to the outdoors for rooms and spaces in residential buildings ventilated by natural sources shall conform to Table 33A. Such ventilation shall not be through an unheated room or space.

(2) Where ventilation openings other than windows or ducts are used to provide any part of the unobstructed ventilation area required by (1), they shall have vent closures that have a thermal resistance of not less than RSI 2.0, seals located on the warm side, and hardware for holding them in any position from fully open to fully closed and for fastening them in the closed position.

33 - 3 rev. 30/05/84

TABLE 33A - NATURAL VENTILATION

Location		Minimum Unobstructed Area
Within dwelling units	Bathrooms or water-closet rooms and service rooms	0.09 m^2
	Unfinished basement space	0.2 percent of the floor area
	Dining rooms, living rooms, bedrooms, kitchens, combined rooms, dens, recreation rooms and all other finished rooms	0.28 m^2 per room or combination of rooms
Other than within dwelling units	Bathrooms or water-closet rooms	0.09 m^2 per water closet
	Sleeping areas	0.14 m^2 per occupant
	Laundry rooms, kitchens and recreation rooms	4 percent of the floor area
	Corridors, storage rooms and other similar public rooms or spaces	2 percent of the floor area
	Unfinished basement space not used on a shared basis	0.2 percent of the floor area

(3) Where operable windows or vents are used to provide any part of the unobstructed ventilation area required by (1) they shall be designed, constructed and installed so as to prevent the formation of frost or ice that would prevent their operation.

(4) Where the requirements in Table 33A are in conflict with the requirements of 9I(2), the greater requirement shall apply.

D. MECHANICAL VENTILATION SYSTEMS

(1) Where a mechanical ventilation system is provided, it shall be designed to be capable of operating continuously and of providing a maximum rate of air change of at least 1.0 ach, based upon the finished interior volume of the dwelling unit. The system shall be provided with a variable speed control and a switch to allow the system to be turned off.

(2) Inlet and exhaust openings shall be so located that they open into the outside air at places where pressures due to winds will be less than 20% of the static pressure of the ventilating fans in operation.

(3) Outside ventilation air shall be tempered to at least 15°C before it enters any habitable room.

(4) Where an outdoor air intake is connected directly into the return air duct of an air circulation system, it shall be fitted with a balancing damper.

(5) Exhaust from laundry driers shall be ducted directly to the outdoors by a duct conforming to E(1), unless other provisions are made for the control of humidity and pollutants.

(6) See Subsection 10I where an exhaust duct serves more than 1 fire compartment.

E. ADDITIONAL REQUIREMENTS FOR VENTILATION SYSTEMS

(1) Air intake and exhaust outlets shall be provided and shall be shielded from the entry of birds, vermin, insects, rain and snow, including wind-driven snow. Screening shall be of rust-proof material. On air intake ducts, insect screening shall be fitted on a separate frame located in a warm space and fitted so as to be easily removable from the inside.

(2) Exhaust outlets that could reverse and air intakes for natural or mechanical ventilation shall be located so as to avoid contamination from combustion equipment, fuel storage tank vents, exhaust outlets, or exhaust from parked vehicles, or from other sources in concentrations greater than normal in the locality in which the building is located.

(3) Cold outside air shall not be introduced into a building or dwelling in such a way as to cause discomfort or to endanger pipes or equipment that might be damaged by freezing.

(4) Where outdoor air is introduced into the return air duct of a hot air furnace, a mixing device or other acceptable means shall be used to ensure that the cold air is tempered with the return air before reaching the heating equipment.

(5) Intake air ducts shall be insulated to prevent condensation from the point where they pass through the building envelope, to the point where the supply air is introduced into the living space or is tempered, as required in D(3). Joints in the ducts shall be sealed, and the insulation shall be encased in an air-tight and vapour retardant membrane. Where subject to mechanical damage and at all locations less than 1.5 m from the floor, the membrane shall be protected by a protective covering.

(6) Intake ducts for ventilation systems shall not pass through a combustion equipment room unless they are airtight and continuous.

(7) Exhaust ducts shall discharge directly to the outside and shall be insulated from the point where they pass through the building envelope to their extremities so as to maintain an inside surface temperature of not less than 10°C under the 1% January design temperature and with an inside house air temperature of 22°C. The ducts shall be sealed against leakage of air into the insulation.

(8) Ventilation equipment shall be accessible for inspection, maintenance, repair and cleaning.

(9) Where a kitchen exhaust duct is not equipped with a removable and washable grease filter at the intake end, the ventilation system to which it is connected shall be designed and installed so that it can be cleaned.

(10) Every ventilating duct shall conform to the requirements of Section 34.

(11) Underground ventilating ducts shall be adequately drained. Such ducts shall have no connections to public or private sewerage systems and shall be provided with access for inspection and cleaning.

6. HEAT RECOVERY SYSTEMS

(1) Where a system is installed to recover waste heat from the exhaust air, it must be so designed as not to unbalance the ventilation system or, by its failure, to impair the performance of the ventilation system, as required in Subsection D.

(2) All air streams entering heat recovery devices shall be filtered by means of cleanable or disposable filters.

(3) The core of a heat recovery device shall be accessible for cleaning or replacement.

(4) The system shall be designed to thaw any frost-blockage of the exhaust passages as quickly as possible and to restart the heat-exchange operation as soon as the exhaust passages are defrosted.

(5) Provisions shall be made to drain off all condensed water to a drainage system.

(6) Heat recovery devices shall be installed according to the provisions of Section 34.

ONTARIO NEW HOME WARRANTY PROGRAM
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BULLETIN

No. 13

January 22, 1985.

BUILDERS RESPOND CONSTRUCTIVELY TO OFFER TROUBLE-FREE ENERGY EFFICIENT HOUSES

We believe that the development of practicable, durable, energy efficient houses is highly desirable. However, it is clear that some of the advances - notably in airtightness - have not been accompanied by full understanding of needed changes in other systems - notably ventilation and heating.

The $20,000 bond for each energy efficient home built under the R.2000 Program, as required in our Bulletin #11, was removed under Bulletin #12 because of blanket security received from the C.H.B.A. for those builders building under the C.H.B.A umbrella. For those not building under the R.2000 Program, safeguards have been developed in co-operation with Ontario industry leaders to help achieve trouble-free low energy housing

WHERE BUILDERS SIGNIFY IN WRITING THAT THEY WILL COMPLY WITH THESE SAFEGUARDS APPROPRIATELY TO THEIR PLANNED NEW HOUSES, NORMAL ONTARIO NEW HOME WARRANTY COVERAGE WILL BE APPLICABLE WITHOUT THE BONDING REQUIREMENTS OF BULLETIN #11.

These attached 'Safeguards' should be regarded as minimum preliminary steps to help avoid known problems in 'airtight' houses. They do not relieve builders of their fundamental obligation to ensure that all houses are designed and built to be capable of safe and reliable performance for a long period of time. While the great majority of new houses are not 'airtight' as defined in the attached 'Safeguards', they are generally much tighter than yesterday's houses, consequently builders must install air supply provisions for all combustion devices.

C. Edmund Locke

C. Edmund Locke,
President/Registrar.

SAFEGUARDS TO HELP ACHIEVE TROUBLE-FREE ENERGY EFFICIENT HOUSING

HOUSES WITH AIRTIGHT ENVELOPE CONSTRUCTION

DEFINITION: Houses must be assumed to have airtight envelopes where -

- an airtightness test conducted in accordance with Standard CAN2-149.10-M85, "Determination of Airtightness of Building Envelopes by the Fan Depressurization Method" indicates an equivalent leakage area of 0.05 m^2 or less, or-

- sealants, adhesives or gaskets are used at laps and joints and around the perimeter of the vapour barrier or interior finish and construction joints.

PURPOSE: These safeguards are intended to help avoid the following problems which can arise in houses with such airtight envelopes and other recently developed energy saving features:

- o backdrafting of the furnace chimney caused by competing devices, such as open fireplaces, exhaust fans and range-top barbecues

- o backdrafting of smouldering open fireplaces caused by competing devices such as furnaces, exhaust fans and range-top barbecues

- o inadequate rate of exchange of indoor air for fresh outdoor air to control indoor humidity and air quality

- o improper manufacture and/or installation of energy saving devices

- o lack of familiarity, on the part of the homebuyer, with the operating procedures necessary in such houses

- o lack of recognition by the builder that an increased level of site supervision is required in the construction of these complex houses

REQUIRED SAFEGUARDS:

Gas or propane furnaces:

1. An atmospheric natural gas or propane furnace and/or water heater (i.e. naturally aspirating, without induced or powered draft provisions) shall not be used.*

2. Non-atmospheric gas or propane furnace, such as induced draft furnaces, must be served by an outside air supply complying with Standard CAN1-B149.1-M80, "Installation Code for Natural Gas Burning Appliances and Equipment", or Standard CAN1-B149.2-M80, "Installation Code for Propane Burning Appliances and Equipment".

Fireplaces, wood stoves:

3. Any solid fuel burning device, such as a fireplace or wood stove, must be equipped with tight-fitting doors and an outside combustion air supply.**

   Clause 9.22.9.2 of the Ontario Building Code must be complied with in regard to clearance between the outdoor intake duct and combustible material.

   The homebuyer shall be provided with instructions emphasizing that the doors should be kept closed during and after usage of the device.

Ventilation:

4. Exhaust fans or equivalent ventilation complying with Clause 9.33.2.1(1) of the Ontario Building Code shall be installed regardless of the type of heating equipment. If a heat recovery ventilator (or other equipment which includes air supply fans) is installed, it shall be installed and adjusted in a manner that ensures that the house will not be pressurized.

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* This safeguard may be waived in the future if design and installation criteria which will ensure the safe operation of such furnaces in these houses and which are acceptable to the Building Code Branch of the Ministry of Municipal Affairs and Housing are developed.

** If required, an excerpt from the February/March, 1984 edition of the CHBA publication "Habitation" is available upon request from the Warranty Program. This excerpt provides guidance on construction of fireplaces meeting the intent of this requirement.

Basic operating instructions shall be provided to the homebuyer and shall include the advice that -

- excessive humidity should be avoided and air quality maintained by opening windows or operating ventilating systems, and -

- the need for such actions is often indicated by considerable fogging or frosting on the inner surface of the inner pane of glazing or by "mustiness" or "stale" air.

Control of water entry below grade:

5. The following provisions of the Ontario Building Code regarding prevention of below-grade water entry shall be complied with:

   - waterproofing and dampproofing - Section 9.13 (except that basement and cellar slabs must be dampproofed even if they are supported on granular fill)

   - foundation drainage - Clauses 9.14.2.1.(1) and 9.16.4.2

   - surface drainage - Clause 9.14.6.1

   - drainage of crawl spaces - Subsection 9.18.5

   - ground cover in crawl spaces - Subsection 9.18.6

Equipment and operation:

6. Where any of the following devices is installed, its manufacture and installation shall comply with the standards indicated:

Automatic Flue Dampers

Manufacture:	CAN1-2.28-M81
Installation:	CAN1-B149.1-M80 (gas) CAN1-B149.2-M80 (propane)

Heat Recovery Ventilators

Manufacture:	CSA-C439-M1986 (draft)
Installation:	CSA-C444-M1985 (draft)

Wood Stoves

Manufacture:	ULC-S627-M1983
Installation:	Ontario Building Code

Fireplaces

Manufacture:	ULC-S610-M1982
Installation:	Ontario Building Code

Moveable Insulating Devices for Windows

Manufacture:	CMHC Interim Standard
Installation:	Manufacturer's instructions

Manuals giving operation and maintenance instructions shall be provided to the homebuyer for all such devices installed in the house.

NOTE: ALL HOUSES BUILT FOR SALE AND WHICH MEET THE DEFINITION OF AN ENERGY EFFICIENT HOUSE MUST BE ENROLLED INTO THE PROGRAM NO LATER THAN THE TIME OF COMMENCEMENT OF CONSTRUCTION AND MUST BE CLEARLY IDENTIFIED ON THE ENROLMENT FORM AS AN ENERGY EFFICIENT HOUSE, AS DEFINED IN THIS BULLETIN.

Inspections:

7. To ensure compliance with the requirements outlined above, the house shall be inspected, under the supervision of a qualified professional engineer, inspection agency, or the builder, at the following stages:

   - ready for basement floor slab
   - insulation and air/vapour barrier complete
   - all equipment installed and operating

A signed and dated record of each inspection shall be provided to the Warranty Program. Where the builder elects to undertake his own inspections, the Warranty Program will require at completion of the house a notarized statement attesting to the fact that the house has been constructed in accordance with the requirements of Bulletin #13.

Strict observance of the required "Safeguards" in this Bulletin is highly important. Builders of homes with airtight envelope construction, as defined, should also note that random inspections of homes will be conducted by Program inspectors and THE OBSERVANCE OF THE REQUIREMENTS LISTED IN THIS BULLETIN WILL BE A CONDITION OF CONTINUED REGISTRATION WITH THIS PROGRAM.

The technology related to this type of housing is still evolving, consequently modifications to current requirements may be made as circumstances change and new information becomes available.

Clause 5.7.4(New)—Add the following Clause:

5.7.4 Mechanical Air Change

5.7.4.1 Each mobile home shall have a mechanical ventilation system capable of providing at least a 0.5 air change per hour based on the interior volume of the mobile home.

5.7.4.2 The ventilation system shall include fresh air inlet(s) and exhaust air outlet(s) sized in accordance with Clause 5.7.4.1.

5.7.4.3 The ventilation system shall be capable of continuous opuration and shall be controlled either automatically, such as by a humidistat or manually by a switch. Where the exhaust fan(s) specified in Clause 5.7.2 (ie, kitchen and bath fans) are used to provide a portion of the 0.5 air change, at least one such fan shall be automatically controlled by a humidistat.

5.7.4.4 Instructions in the use of the ventilation system as a means of reducing condensation problems shall be provided in the owner's manual in accordance with Clause 9.2.

April, 1984
Amendment No. 11 *Z240.2.1-1979*

Clause 9.2(New)—Add the following Clause:

9.2 Mechanical Ventilation System
Instructions in the use of the mechanical ventilation system specified in Clause 5.7.4 shall be included in the owner's manual.

April, 1984
Amendment No. 16 *Z240.2.1-1979*